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RESEARCH MEMORANDUM

EFFECTIVENESS AT TRANSONIC SPEEDS OF FLAP-TYPE
AILERONS FOR SEVERAL SPANWISE LOCATIONS ON A
4-PERCENT-THICK SWEPTBACK-WING—FUSELAGE
MODEL WITH AND WITHOUT TAILS

By Gerald Hieser and Charles F. Whitcomb

Langley Aeronautical Laboratory
Langley Field, Va.

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Page 3⁴: The attached corrected figure 10 should be used to replace the original plot which was found to have the vertical scale of rolling-moment coefficient C_l at $M = 0.80$ displaced by an increment of 0.01.

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RESEARCH MEMORANDUM

EFFECTIVENESS AT TRANSONIC SPEEDS OF FLAP-TYPE
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SUMMARY

A transonic investigation has been made in the Langley 16-foot transonic tunnel to determine the effects of spanwise location of a flap-type aileron on the lateral characteristics of a 4-percent-thick sweptback-wing-fuselage model. Some effects of the model tail on the lateral characteristics are also included. The inboard, midspan, and outboard ailerons have a span of 40 percent of the wing semispan and a chord of 30 percent of the wing chord. The tests covered Mach numbers from 0.80 to 1.03 and angles of attack up to 27°.

For the model with no tail, the outboard aileron effectiveness was the lowest at angles of attack up to 12° while the inboard and midspan ailerons had about equal effectiveness. The effects of the empennage on the model lateral characteristics with the inboard aileron deflected were generally greater than the effects on the characteristics with the midspan aileron deflected. With the inboard ailerons differentially deflected 15°, addition of the empennage caused a reduction in the rolling moment at low angles of attack and at all Mach numbers. The largest reduction amounted to about 30 percent of the rolling moment for the model with no tail.

INTRODUCTION

Experimental research at transonic speeds to determine lateral control characteristics of flap-type ailerons is needed because the available data are meager and theory is inadequate for accurate prediction of control effectiveness. Most existing information has been obtained from tests of small-scale models by utilizing the transonic-bump and wing-flow

techniques. (See, for example, refs. 1 to 3.) Accordingly, effectiveness and loading characteristics of flap-type controls on relatively large-scale unswept, sweptback, and delta wings are being investigated in the Langley 16-foot transonic tunnel at Mach numbers up to and slightly above 1.0. Results from an unswept-wing model investigation are reported in reference 4. The present paper includes effectiveness information obtained from tests of a 45° sweptback-wing model with inboard, midspan, and outboard ailerons. In addition, the effects of a horizontal tail, a vertical tail, and the complete empennage on the lateral characteristics are included.

The sting-supported model used for the investigation has a 45° sweptback wing with an aspect ratio of 3, a taper ratio of 0.2, and NACA 65A004 airfoil sections streamwise. The longitudinal characteristics of this model without ailerons are presented in reference 5. For the present investigation the model was equipped with inboard, midspan, and outboard unbalanced ailerons, each having a span of 40 percent of the wing semi-span and a chord of 30 percent of the wing chord. Data have been obtained at Mach numbers from 0.80 to 1.03, angles of attack up to 27° , and aileron deflections to approximately $\pm 15^{\circ}$. The test Reynolds number was approximately 7×10^6 .

SYMBOLS

The model forces and moments have been reduced to the stability system of axes.

b	wing span
c	local wing chord
c'	wing mean aerodynamic chord
C _L	lift coefficient, $\frac{\text{Lift}}{qS}$
C _l	Rolling-moment coefficient, $\frac{\text{Rolling moment}}{qSb}$
C _n	yawing-moment coefficient, $\frac{\text{Yawing moment}}{qSb}$
C _Y	lateral-force coefficient, $\frac{\text{Lateral force}}{qS}$
M	free-stream Mach number

- q free-stream dynamic pressure
 S wing area
 α angle of attack of model (fuselage center line)
 δ aileron deflection angle in plane normal to aileron hinge line
 (positive when trailing edge is down)
 δ_N nominal aileron deflection (not corrected for deflection due
 to load)
 Λ sweep angle
 $C_{l\delta} = \left(\frac{\partial C_l}{\partial \delta} \right)_{\alpha}$
 $C_{L\delta} = \left(\frac{\partial C_L}{\partial \delta} \right)_{\alpha}$
 S_a aileron area
 \bar{y} moment arm of aileron; distance from aileron center of area to
 rolling-moment axis

MODEL AND APPARATUS

Model

The aluminum-alloy wing, which has 45° sweep of the quarter-chord line, was mounted on the body in a midwing position and was designed for no geometric twist, incidence, or dihedral. The airfoil sections parallel to the plane of symmetry are NACA 65A004. Coordinates of this section are given in reference 5 and the fuselage ordinates are given in reference 6.

The unbalanced trailing-edge ailerons were composed of four segments on each wing and were deflected in adjacent pairs to simulate the inboard, midspan, and outboard configuration. Aileron deflection was accomplished by utilizing tongues mounted between the wing and ailerons at the hinge line. These tongues were bent to obtain nominal deflections of 0° , $\pm 7.5^\circ$, and $\pm 15^\circ$ perpendicular to the hinge line. On the left wing the tongue for each segment covered its full span so that no gap existed between the wing and aileron. On the right wing, however, two separate tongues 0.86 inch in width spanwise were utilized to attach each of the four

aileron segments. A gap of about 0.4 percent of the wing chord, therefore, existed over 71 percent of the aileron span.

The horizontal tail has a sweep angle of 45° of the quarter-chord line and was mounted on the model in the wing chord plane extended at an incidence of -4° . The vertical tail also has 45° sweepback of the quarter-chord line.

Pertinent dimensions and geometric details of the model are given in figure 1 and photographs of the model are given as figure 2.

Apparatus

The tests were conducted in the Langley 16-foot transonic tunnel, which is an atmospheric wind tunnel with an octagonal slotted test section permitting a continuous variation in speed to Mach numbers slightly above 1.0. (See ref. 7.) The sting-support system is arranged so that the model is located near the center of the tunnel at all angles of attack.

Model forces and moments were measured by a six-component internal strain-gage balance, and angle of attack by a strain-gage attitude transmitter.

TESTS

Simultaneous measurements of model forces and moments were obtained for the following configurations:

Purpose	δ_N						Horizontal tail	Vertical tail		
	Right-wing aileron			Left-wing aileron						
	Inboard	Midspan	Outboard	Inboard	Midspan	Outboard				
Spanwise effect	0	0	0	0	0	0	Off	Off		
	7.5	0	0	0	0	0	Off	Off		
	15	0	0	0	0	0	Off	Off		
	-7.5	0	0	0	0	0	Off	Off		
	-15	0	0	0	0	0	Off	Off		
	0	7.5	0	0	0	0	Off	Off		
	0	15	0	0	0	0	Off	Off		
	0	-7.5	0	0	0	0	Off	Off		
	0	-15	0	0	0	0	Off	Off		
	0	0	7.5	0	0	0	Off	Off		
	0	0	-7.5	0	0	0	Off	Off		
	0	0	-15	0	0	0	Off	Off		
Tail effect	-15	0	0	15	0	0	Off	Off		
	-15	0	0	15	0	0	On	Off		
	-15	0	0	15	0	0	Off	On		
	-15	0	0	15	0	0	On	On		
	15	0	0	0	0	0	On	On		
	0	15	0	0	0	0	On	On		

Tests of the model configurations given in the table were made at Mach numbers from 0.80 to 1.03. The angle of attack varied from -3.6° to a maximum of 27.4° at the lower loading conditions, and from 0° to 10.6° at the highest loadings.

The Reynolds number based on wing mean aerodynamic chord varied from about 6.7×10^6 to 7.7×10^6 .

ACCURACY

The measurement of Mach number in the test region is believed to be accurate within ± 0.005 , and the angles of attack presented are estimated to be correct within $\pm 0.1^\circ$.

The aileron deflection angles were obtained from the nominal angle and a deflection due to load. This deflection due to load was determined from a static calibration of applied load measured by strain gages mounted on the supporting tongues between the wing and ailerons. The resulting values of δ are believed to be accurate within $\pm 0.25^\circ$.

No adjustments to the measured forces and moments have been applied to account for sting interference or aeroelasticity. Elastic properties of the basic wing without ailerons obtained from static loadings are given in reference 8.

The accuracy of the model balance is believed to be within $\pm 1/2$ percent of the maximum forces and moments encountered.

RESULTS

A complete listing of the basic data from the aileron-spanwise-location investigation of the model without tails is presented in table I. The tabulation includes results from deflection of the ailerons at the three spanwise locations on the right wing only. Some sample plots of the lateral data taken from cross plots of the results listed in table I are presented in figures 3, 4, and 5.

DISCUSSION

Some sample curves showing effects of angle of attack on the rolling-moment coefficient of the model with no tail are shown in figure 6. Results for the model with the three different ailerons deflected to nominal angles of $\pm 7.5^\circ$ are presented for Mach numbers of 0.80 and 1.03. For negative aileron deflections, the rolling-moment coefficient generally increases with increasing model attitude up to an angle of attack of about 4° to 8° , above which some decreases in rolling-moment coefficient occur. Positive aileron deflections result in a decreasing rolling-moment coefficient as the angle of attack is increased to approximately 20° , after which a rapid increase occurs.

Effect of Aileron Spanwise Position on Roll

and Lift Effectiveness

Effectiveness parameters.- Figure 7 presents the variation of the aileron roll-effectiveness parameter $C_{l\delta}$ and the aileron lift-effectiveness parameter $C_{L\delta}$ with Mach number for the three spanwise

locations of the ailerons on the model with no tail. The values of these parameters were obtained by slope measurements in the vicinity of zero aileron deflection from plots similar to figure 3. For angles of attack up to and including 12° , the outboard aileron, which has the least area, has less roll effectiveness than either the inboard or midspan ailerons which have essentially equal effectiveness (fig. 7(a)). Furthermore, the induced load due to aileron deflection on the portions of the wing not occupied by the aileron is probably smaller for the outboard configuration than for either the inboard or the midspan. This relative induced-loading characteristic is probably amplified by the fact that the wing is swept. Although the roll effectiveness of the inboard and midspan ailerons are about equal, the lift effectiveness of the inboard aileron is greater (see fig. 7(b)). It therefore follows that the center of load due to aileron deflection shifts farther from the roll axis for the midspan aileron.

At an angle of attack of 20° , the roll effectiveness of the inboard aileron is very small and, in fact, is zero over part of the Mach number range (fig. 7(a)). The midspan and outboard ailerons retain some effectiveness, the outboard aileron being the more effective at Mach numbers up to 0.93, after which the midspan aileron becomes more effective.

As in the case of the roll effectiveness, the outboard aileron has the least lift effectiveness at angles of attack up to at least 12° (figure 7(b)). The inboard aileron lift effectiveness, however, is greater than the midspan effectiveness at all Mach numbers. This sequence of lift effectiveness, increasing from outboard to inboard, results from the relative aileron areas and from the relative induced loading which increases as the aileron is moved inboard.

Normalized effectiveness parameters. - It is shown empirically in reference 9 that at supersonic speeds the lift effectiveness of an aileron can be related to its area and the roll effectiveness to the aileron moment of area about the roll axis. For the mixed-flow case of the transonic speed range this simple concept is not necessarily valid. However, normalizing the measured effectiveness parameters of $C_{l\delta}$ and $C_{L\delta}$ on the basis of their respective moments of area and areas for the three ailerons tested should present a relative picture of the performance of the three ailerons without regard to their geometry or location. Such normalized values for the three ailerons are presented in figure 8. For angles of attack through 12° both the normalized roll-effectiveness parameter $C_{l\delta} \frac{S_b}{S_a \bar{y}}$ and the normalized lift-effectiveness parameter $C_{L\delta} \frac{S}{S_a}$ are the greatest for the inboard aileron and the least for the outboard. That is, for a unit of aileron moment of area or a unit of aileron area, the inboard aileron position is the most effective and the outboard

position is the least effective. At an angle of attack of 20° the trends of the normalized roll effectiveness parameters for the three ailerons follow the same pattern as the parameter $C_{l\delta}$. The outboard aileron is somewhat more effective than the other two for Mach numbers up to about 0.92. This is also indicated by the normalized lift-effectiveness parameter at this angle.

Tail Effects

Previous investigations to determine the effectiveness of lateral controls on models include very little information which defines the effects of a tail or complete empennage on the model lateral characteristics, particularly in the transonic speed range. That is, the effects of changes in the tail loads which result from changes in the model downwash and sidewash caused by deflection of lateral controls have been largely neglected. Accordingly, the present investigation includes tests of the model with a horizontal tail, vertical tail, and complete empennage.

Inboard ailerons.- A vertical tail and a horizontal tail have been added separately and in combination to the model with the inboard ailerons differentially deflected 15° each on opposite wing panels. The lateral characteristics of these configurations are presented in figure 9. The results of the tails-off model tests indicate that the rolling-moment coefficient decreases rapidly above an angle of attack of approximately 4° at a Mach number of 0.80. This rapid decrease is delayed to an angle of attack of about 10° for the higher Mach numbers of 0.98 and 1.03. These trends are essentially the same for the three tail-on configurations tested. A reduction in rolling-moment coefficient over the angle-of-attack range up to approximately 8° or 10° occurred at all Mach numbers when either or both of the tails were added to the model. The largest of these reductions was about 30 percent and occurred when the combined tails were added. This latter result is in agreement with results from tests of a free-flying model with and without a free-to-roll tail, wherein the effects of tail damping are considered (ref. 10).

Observation of the decrements caused by the individual vertical and horizontal tails indicates that the horizontal tail contributes the greatest part of the reduction in rolling-moment coefficient (fig. 9). This reduction is probably due to changes in tail loading of opposite sign on the two tail panels which results from changes in wing downwash caused by the differentially deflected ailerons. At angles of attack above about 10° , addition of the vertical tail alone causes an increase in the rolling-moment coefficient, whereas at lower angles a decrease is noted. This change in sign of the rolling-moment increment results from the fact that the center of load on the vertical tail shifts from a position above the roll axis to a position below the axis as the angle of

attack is increased. The increments in side-force and yawing-moment coefficients due to the effect of sidewash on the vertical tail increase with increasing Mach number up to a Mach number of about 0.98.

Transonic tests of a body-mounted lateral-control device adapted to the present basic wing-fuselage configuration have been made and the results have been published in reference 11. Addition of the empennage to this configuration altered the magnitudes of the lateral coefficients by about the same percentages as for the present inboard aileron configuration.

Inboard and midspan ailerons. - A comparison of the model lateral characteristics obtained with the right-wing inboard and midspan ailerons individually deflected 15° and the empennage on and off is presented for Mach numbers of 0.80 and 0.98 in figure 10. Generally, the tail has a greater effect on the lateral characteristics of the inboard aileron configuration than on those of the midspan aileron configuration. Adding the tails reduced the rolling-moment coefficients of the inboard aileron model by about 0.0050 at angles of attack up to 6° but had essentially no effect on the midspan aileron model at these same low angles. The tail effects on the model yawing-moment and side-force coefficients were about twice as great for the inboard aileron configuration as for the midspan aileron over the angle-of-attack and Mach number ranges tested. The changes in the wing downwash and sidewash in the vicinity of the tail are therefore much greater for the inboard aileron deflections than for the midspan.

Effect of Spanwise Aileron Position on Complete Model Rolling-Moment Characteristics

In the discussion of the characteristics of the model with no tail, it was shown that the midspan and inboard ailerons have about the same effectiveness. It was also established that the downwash and sidewash effects on the empennage loads are more detrimental to the model rolling moment with the inboard ailerons deflected than with the midspan ailerons. As a result, the midspan ailerons are more effective on the complete model than the inboard ailerons. (See fig. 10.)

Because the present investigation did not include tests of the outboard aileron configuration with a tail on the model, insufficient information is available to obtain a direct comparison of the midspan and outboard aileron effectiveness for the complete model. An indication of the relative merits of these two configurations, however, can be gained by referring to the data of figures 6 and 10 and to results shown in reference 10. In figure 6 a comparison of the midspan and outboard ailerons for the model with no tail reveals that the midspan aileron generally

produces somewhat greater rolling-moment coefficients than the outboard aileron. Referring to the data of figure 10 at small angles of attack, it is shown that the effect of the empennage on the midspan aileron rolling moment is detrimental but small. Likewise, the data of reference 10 reveal that the empennage effect on the effectiveness of an outboard aileron is detrimental and small. Apparently, therefore, it might be expected that, for the complete model, the midspan aileron would be somewhat more effective than the outboard aileron. Since it has been established that the midspan aileron is more effective than the inboard aileron, it is reasoned that the midspan location should be the best for a complete configuration of this type.

CONCLUSIONS

A comparison of the transonic lateral characteristics of a 4-percent-thick 45° sweptback-wing-fuselage model equipped with 30-percent-chord flap-type ailerons located at three different spanwise positions has been made. The effects of a horizontal tail, a vertical tail, and the complete empennage are included.

1. For the model with the tail off, the outboard aileron effectiveness was the lowest of the three at angles of attack up to at least 12°, while the inboard and midspan ailerons had about equal effectiveness. When the effectiveness parameters were normalized to eliminate the effect of geometric characteristics, the inboard aileron had the greatest roll effectiveness and the outboard had the least.

2. With the inboard ailerons differentially deflected 15°, addition of the empennage caused a reduction in the model rolling-moment coefficient at angles of attack up to about 8° or 10° at all Mach numbers. The largest reduction amounted to about 30 percent of the rolling-moment coefficient for the model with no tail.

3. The effects of the empennage on the model lateral characteristics with the inboard aileron deflected were generally greater than the effects on the characteristics of the model with the midspan aileron deflected. Adding the empennage reduced the rolling-moment coefficient about 0.0050 at angles of attack up to about 6° with the inboard aileron deflected 15° on one wing, while essentially no change in rolling moment resulted from the presence of the empennage on the model at these angles of attack with the midspan aileron deflected.

Langley Aeronautical Laboratory,
National Advisory Committee for Aeronautics,
Langley Field, Va., September 18, 1956.

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TABLE I.- BASIC DATA FOR MODEL WITH AILERONS ON RIGHT WING

[tail off]

(a) Inboard aileron

M = 0.80							M = 0.90						
α	δ	C_L	C_Y	C_Z	C_n		α	δ	C_L	C_Y	C_Z	C_n	
-0.04	-14.71	-0.1369	0.0001	0.0154	0.0001		-0.03	-14.54	-0.1331	-0.0007	0.0150	0.0011	
1.97	-14.73	-0.0177	0.0017	0.0160	-0.0009		1.87	-14.59	-0.1310	0.0013	0.0155	-0.0000	
3.98	-14.77	0.1084	0.0038	0.0170	-0.0021		3.77	-14.63	0.1103	0.0036	0.0173	-0.0011	
5.99	-14.79	0.2352	0.0060	0.0188	-0.0035		5.70	-14.67	0.2458	0.0055	0.0185	-0.0023	
8.01	-14.80	0.3707	0.0069	0.0191	-0.0043		7.61	-14.70	0.3794	0.0067	0.0184	-0.0033	
10.01	-14.81	0.4757	0.0075	0.0146	-0.0047		9.52	-14.72	0.4873	0.0076	0.0198	-0.0041	
12.93	-15.07	0.6640	0.0103	0.0128	-0.0066		11.42	-14.88	0.5760	0.0084	0.0147	-0.0050	
13.98	-15.03	0.6947	0.0092	0.0125	-0.0070		13.03	-15.12	0.6638	0.0104	0.0124	-0.0056	
17.10	-15.39	0.8111	0.0113	0.0094	-0.0080		15.14	-15.37	0.7593	0.0114	0.0118	-0.0065	
19.05	-15.38	0.8133	0.0103	0.0067	-0.0068		17.24	-15.47	0.8421	0.0124	0.0101	-0.0077	
21.05	-15.41	0.8734	0.0094	0.0045	-0.0070		19.26	-15.56	0.8834	0.0111	0.0068	-0.0062	
24.98	-15.61	0.9698	0.0020	-0.0120	0.0052		21.22	-15.63	0.9250	0.0117	-0.0017	-0.0050	
							25.18	-15.82	1.0262	0.0006	-0.0106	0.0024	
-0.04	-7.39	-0.0796	0.0004	0.0076	-0.0005		-0.04	-7.33	-0.0789	-0.0010	0.0086	-0.0000	
1.97	-7.42	0.0444	0.0010	0.0077	-0.0009		1.97	-7.32	0.0476	0.0004	0.0093	-0.0005	
3.98	-7.44	0.1669	0.0027	0.0094	-0.0014		4.00	-7.41	0.1821	0.0023	0.0106	-0.0012	
5.99	-7.45	0.3003	0.0037	0.0096	-0.0022		5.99	-7.44	0.3243	0.0033	0.0102	-0.0016	
8.01	-7.46	0.4415	0.0042	0.0105	-0.0027		8.03	-7.45	0.4732	0.0047	0.0111	-0.0024	
9.99	-7.47	0.5301	0.0047	0.0072	-0.0027		9.99	-7.46	0.5785	0.0048	0.0096	-0.0026	
11.98	-7.57	0.6447	0.0052	0.0069	-0.0036		11.98	-7.66	0.6571	0.0058	0.0079	-0.0033	
12.99	-7.74	0.7031	0.0057	0.0061	-0.0036		13.07	-7.85	0.6969	0.0065	0.0061	-0.0031	
13.98	-7.67	0.7360	0.0060	0.0058	-0.0042		15.20	-8.01	0.8063	0.0078	0.0061	-0.0048	
17.10	-7.96	0.8408	0.0064	0.0045	-0.0038		17.27	-8.10	0.8737	0.0079	0.0047	-0.0036	
18.99	-7.96	0.8603	0.0062	0.0031	-0.0034		19.19	-8.16	0.9195	0.0071	0.0018	-0.0041	
20.93	-7.97	0.9020	0.0054	0.0011	-0.0038		21.22	-8.23	0.9648	0.0074	-0.0027	-0.0022	
24.89	-8.20	0.7208	-0.0036	-0.0138	0.0086		25.18	-8.24	1.0808	-0.0032	-0.0111	0.0057	
-3.65	0.05	-0.2314	-0.0006	-0.0011	-0.0006		-3.62	0.06	-0.2422	-0.0004	-0.0016	-0.0007	
-1.56	0.02	-0.1010	-0.0005	-0.0012	-0.0004		-1.66	0.03	-0.1170	-0.0003	-0.0014	-0.0004	
-0.58	0.00	-0.0422	-0.0001	-0.0010	-0.0003		-0.56	0.00	-0.0452	-0.0002	-0.0012	-0.0005	
1.41	-0.02	0.0704	-0.0002	-0.0005	-0.0004		1.43	-0.02	0.0783	0.0000	-0.0005	-0.0003	
2.43	-0.03	0.1334	0.0001	-0.0005	-0.0002		2.41	-0.03	0.1427	0.0002	-0.0000	-0.0002	
4.47	-0.06	0.2678	0.0001	0.0007	-0.0001		4.47	-0.07	0.2958	0.0007	-0.0007	-0.0001	
6.44	-0.08	0.4029	0.0003	0.0010	0.0001		6.40	-0.09	0.4365	0.0005	0.0017	-0.0000	
8.38	-0.08	0.5268	0.0009	0.0018	-0.0004		8.34	-0.11	0.5668	0.0010	0.0027	-0.0006	
10.45	-0.19	0.6167	0.0009	0.0014	-0.0007		10.49	-0.13	0.6353	0.0009	0.0012	-0.0005	
11.39	-0.21	0.6732	0.0012	0.0013	-0.0006		11.48	-0.34	0.6780	0.0014	0.0014	-0.0006	
12.50	-0.24	0.7238	0.0007	0.0011	-0.0006		12.53	-0.39	0.7226	0.0012	0.0010	-0.0006	
13.53	-0.30	0.7674	0.0015	0.0008	-0.0007		13.64	-0.45	0.7841	0.0017	0.0012	-0.0007	
15.65	-0.39	0.8405	0.0012	0.0011	-0.0013		15.77	-0.55	0.8707	0.0020	0.0013	-0.0013	
17.72	-0.48	0.8929	0.0004	0.0005	-0.0012		17.89	-0.66	0.9373	0.0004	0.0001	-0.0006	
19.72	-0.55	0.8983	-0.0006	0.0003	-0.0014		19.95	-0.73	0.9707	-0.0015	-0.0006	-0.0002	
21.79	-0.61	0.9456	-0.0063	-0.0021	0.0010		22.01	-0.82	1.0089	-0.0052	-0.0032	0.0028	
23.88	-0.55	0.9937	-0.0166	-0.0065	0.0073		24.13	-0.95	1.0715	-0.0158	-0.0084	0.0087	
							26.23	-0.98	1.1238	-0.0199	-0.0113	0.0121	
-0.02	7.40	0.0597	0.0001	-0.0096	-0.0005		-0.08	7.35	0.0665	-0.0013	-0.0105	-0.0000	
1.99	7.38	0.1796	-0.0004	-0.0101	0.0003		1.93	7.30	0.1960	-0.0020	-0.0100	0.0008	
3.98	7.35	0.3065	-0.0012	-0.0089	0.0012		3.94	7.26	0.3408	-0.0028	-0.0089	0.0014	
5.99	7.33	0.4463	-0.0013	-0.0080	0.0012		5.95	7.23	0.4786	-0.0034	-0.0075	0.0019	
8.01	7.36	0.5697	-0.0020	-0.0064	0.0013		7.98	7.18	0.6058	-0.0027	-0.0075	0.0021	
9.99	7.25	0.6278	-0.0021	-0.0043	0.0016		9.95	7.21	0.6838	-0.0023	-0.0036	0.0013	
11.98	7.16	0.7428	-0.0021	-0.0034	0.0017		11.94	7.05	0.7422	-0.0030	-0.0025	0.0014	
13.05	7.06	0.7920	-0.0015	-0.0037	0.0016		13.15	6.93	0.7880	-0.0023	-0.0035	0.0021	
17.02	6.96	0.9036	0.0002	-0.0015	0.0001		17.31	6.77	0.9495	-0.0002	-0.0010	0.0005	
19.01	6.90	0.9073	-0.0009	-0.0013	0.0007		19.28	6.74	0.9853	0.0010	0.0004	-0.0009	
20.97	6.86	0.9499	-0.0028	-0.0017	-0.0011		21.12	6.66	1.0076	-0.0024	-0.0006	-0.0001	
24.89	6.75	1.0365	-0.0160	-0.0036	0.0046		25.07	6.55	1.0103	-0.0184	-0.0028	0.0056	
-0.03	14.74	0.1224	-0.0003	-0.0179	0.0003		-0.03	14.56	0.1241	-0.0008	-0.0176	0.0009	
1.67	14.71	0.2347	-0.0018	-0.0177	0.0017		1.96	14.52	0.2438	-0.0020	0.0158	0.0023	
3.77	14.69	0.3631	-0.0031	-0.0170	0.0026		3.96	14.49	0.3868	-0.0033	0.0146	0.0035	
5.70	14.69	0.4862	-0.0043	-0.0158	0.0035		5.98	14.46	0.5234	-0.0044	0.0123	0.0046	
7.61	14.68	0.5962	-0.0049	-0.0144	0.0039		7.98	14.44	0.6483	-0.0044	0.0123	0.0045	
9.52	14.61	0.6588	-0.0047	-0.0078	0.0038		9.98	14.49	0.7176	-0.0039	0.0076	0.0042	
11.42	14.54	0.7466	-0.0048	-0.0057	0.0035		11.94	14.39	0.7652	-0.0066	0.0016	0.0184	

CONT'D

TABLE I.- BASIC DATA FOR MODEL WITH AILERONS ON RIGHT WING - Continued

[ail off]

(a) Inboard aileron - Continued

 $M = 0.94$

α	δ	C_L	C_Y	C_z	C_n
-0.03	-14.43	-0.1298	-0.0016	0.0139	0.0019
1.87	-14.49	-0.0051	0.0007	0.0163	0.0007
5.70	-14.59	0.2726	0.0051	0.0199	-0.0019
7.61	-14.62	0.4066	0.0074	0.0205	-0.0024
9.52	-14.64	0.5255	0.0090	0.0218	-0.0044
11.42	-14.77	0.5981	0.0095	0.0195	-0.0053
13.07	-14.89	0.6905	0.0112	0.0176	-0.0064
15.22	-15.27	0.7733	0.0131	0.0127	-0.0065
17.27	-15.50	0.8680	0.0157	0.0117	-0.0093
19.36	-15.64	0.9472	0.0165	0.0094	-0.0098
21.38	-15.76	1.0000	0.0133	0.0048	-0.0096

 $M = 0.98$

α	δ	C_L	C_Y	C_z	C_n
-0.03	-14.31	-0.1156	-0.0022	0.0137	0.0023
1.87	-14.37	0.0147	-0.0001	0.0169	0.0014
5.70	-14.45	0.1496	0.0030	0.0185	-0.0004
7.61	-14.52	0.2876	0.0053	0.0196	-0.0017
9.52	-14.59	0.4207	0.0081	0.0214	-0.0033
11.42	-14.64	0.5402	0.0110	0.0229	-0.0052
13.07	-14.63	0.6495	0.0132	0.0230	-0.0067
15.22	-14.83	0.7471	0.0162	0.0234	-0.0092
17.27	-14.98	0.8537	0.0214	0.0226	-0.0123
19.36	-15.31	0.9429	0.0255	0.0208	-0.0152
21.38	-15.67	1.0172	0.0264	0.0140	-0.0171
	21.48	1.0867	0.0230	0.0086	-0.0169

-0.01	-7.23	-0.0846	-0.0006	0.0084	0.0006
1.89	-7.31	0.0454	0.0008	0.0096	-0.0000
3.79	-7.36	0.1859	0.0023	0.0111	-0.0008
5.72	-7.43	0.3331	0.0038	0.0109	0.0016
7.63	-7.48	0.4618	0.0056	0.0111	-0.0028
9.54	-7.51	0.5836	0.0072	0.0120	-0.0036
11.45	-7.55	0.6634	0.0076	0.0112	-0.0041
13.13	-7.81	0.7369	0.0078	0.0087	-0.0042
15.22	-8.05	0.8197	0.0094	0.0053	-0.0043
17.29	-8.20	0.9148	0.0109	0.0056	-0.0059
19.32	-8.27	0.9907	0.0112	0.0030	-0.0074
21.40	-8.16	1.0510	0.0089	0.0008	-0.0054
25.35	-8.25	1.1613	-0.0063	-0.0059	-0.0003
	25.43				
-0.01	-7.13	-0.0704	-0.0013	0.0078	0.0009
1.89	-7.21	0.0619	0.0003	0.0097	-0.0000
3.79	-7.31	0.1971	0.0023	0.0108	-0.0009
5.72	-7.39	0.3308	0.0042	0.0124	-0.0015
7.63	-7.44	0.4636	0.0062	0.0142	-0.0028
9.54	-7.48	0.5852	0.0085	0.0125	-0.0042
11.45	-7.60	0.6977	0.0108	0.0133	-0.0057
13.15	-7.76	0.7957	0.0128	0.0127	-0.0074
15.28	-7.89	0.9108	0.0163	0.0122	-0.0097
17.39	-8.01	0.9747	0.0153	0.0055	-0.0093
19.42	-8.10	1.0777	0.0176	0.0054	-0.0115
21.51	-8.39	1.1367	0.0184	0.0034	-0.0129
25.35	-8.40	1.2570	-0.0001	-0.0028	-0.0110

-1.36	0.04	-0.1079	-0.0006	-0.0019	-0.0003
0.37	0.03	0.0109	-0.0001	-0.0008	-0.0001
1.42	-0.03	0.0896	-0.0001	-0.0002	-0.0000
2.40	-0.06	0.1600	-0.0000	-0.0001	-0.0000
4.36	-0.14	0.3086	0.0006	0.0016	-0.0000
6.40	-0.21	0.4588	0.0009	0.0015	-0.0002
8.33	-0.25	0.5809	0.0016	0.0037	-0.0005
10.43	-0.20	0.6980	0.0015	0.0029	-0.0010
11.56	-0.24	0.7393	0.0019	0.0015	-0.0004
12.45	-0.28	0.7539	0.0012	0.0014	-0.0005
13.69	-0.51	0.7994	0.0025	0.0019	-0.0010
15.84	-0.61	0.9057	0.0019	0.0011	-0.0012
17.98	-0.76	0.9952	0.0017	0.0012	-0.0015
20.11	-0.87	1.0732	0.0002	0.0006	-0.0017
22.20	-0.97	1.1197	-0.0060	-0.0013	-0.0002
24.28	-0.96	1.1657	-0.0175	-0.0038	-0.0035
26.40	-1.13	1.2220	-0.0218	-0.0050	-0.0066

-0.12	7.26	0.0558	-0.0009	-0.0110	0.0005
1.89	7.21	0.1843	-0.0016	-0.0095	0.0012
3.90	7.14	0.3288	-0.0024	-0.0071	0.0021
5.91	7.09	0.4778	-0.0030	-0.0069	0.0020
7.93	7.10	0.6052	-0.0021	-0.0061	0.0023
9.91	7.11	0.7113	-0.0019	-0.0037	0.0019
11.90	7.14	0.7848	-0.0025	-0.0051	0.0024
13.23	7.01	0.8489	-0.0023	-0.0045	0.0024
15.26	6.75	0.9151	-0.0015	-0.0014	0.0026
17.35	6.66	1.0021	-0.0005	-0.0002	0.0008
19.42	6.61	1.0660	0.0002	0.0004	-0.0008

-0.05	14.42	0.1207	-0.0018	-0.0176	0.0022
1.96	14.42	0.2413	-0.0030	-0.0151	0.0037
3.96	14.35	0.3821	-0.0043	-0.0128	0.0047
5.98	14.29	0.5227	-0.0049	-0.0128	0.0047
7.98	14.27	0.6570	-0.0053	-0.0118	0.0052
9.98	14.26	0.7589	-0.0049	-0.0096	0.0049
11.94	14.28	0.8396	-0.0051	-0.0098	0.0051
-0.05	14.35	0.1023	-0.0021	-0.0162	0.0024
1.96	14.31	0.2285	-0.0035	-0.0140	0.0035
3.96	14.26	0.3696	-0.0045	-0.0120	0.0045
5.98	14.20	0.5179	-0.0055	-0.0102	0.0049
7.98	14.17	0.6502	-0.0060	-0.0103	0.0052
9.98	14.12	0.7620	-0.0065	-0.0113	0.0055
11.94	14.07	0.8730	-0.0060	-0.0093	0.0057

TABLE I.- BASIC DATA FOR MODEL WITH AILERONS ON RIGHT WING - Continued

[Tail off]

(a) Inboard aileron - Concluded

 $M = 1.00$

α	δ	C_L	C_Y	C_z	C_n
-0.03	-14.24	-0.111	-0.0022	0.132	0.023
1.87	-14.30	0.139	-0.0000	0.165	0.012
3.77	-14.39	1.431	0.0030	0.185	-0.0003
5.70	-14.47	2.829	0.0055	0.198	-0.0016
7.61	-14.53	4.121	0.0086	0.211	-0.0033
9.52	-14.53	5.291	0.0115	0.225	-0.0050
11.42	-14.61	6.429	0.0137	0.227	-0.0072

 $M = 1.03$

α	δ	C_L	C_Y	C_z	C_n
-0.03	-14.21	-0.1044	-0.0023	0.140	0.023
1.87	-14.28	0.311	.0004	0.160	0.010
3.77	-14.39	1.589	0.030	0.168	-0.005
5.70	-14.47	3.019	0.057	0.184	-0.019
7.61	-14.52	4.237	0.080	0.205	-0.033
9.52	-14.54	5.341	0.105	0.222	-0.052
11.42	-14.61	6.376	0.129	0.217	-0.071

α	δ	C_L	C_Y	C_z	C_n
0.30	-7.15	-0.0424	-0.0010	0.080	0.008
2.31	-7.24	0.929	0.012	0.097	-0.001
4.32	-7.32	2.285	0.030	0.108	-0.010
6.33	-7.41	3.700	0.049	0.124	-0.020
8.34	-7.45	5.048	0.074	0.138	-0.035
10.33	-7.51	6.206	0.098	0.140	-0.051
12.33	-7.68	7.428	0.123	0.132	-0.068

α	δ	C_L	C_Y	C_z	C_n
-3.59	0.16	-0.2398	0.002	-0.0015	-0.0002
-1.58	0.07	-0.1120	0.001	-0.0011	-0.0000
0.49	-0.00	0.176	0.005	-0.0007	0.0002
1.49	-0.05	0.819	0.006	-0.0006	0.0001
2.50	-0.08	1.527	0.007	-0.0000	0.0003
4.43	-0.18	2.866	0.010	0.0006	0.0004
6.47	-0.27	4.257	0.013	0.0009	0.0004
8.48	-0.35	5.646	0.018	0.0017	0.0002
10.46	-0.42	6.897	0.019	0.0012	-0.0003
12.31	-0.49	7.964	0.019	0.0013	-0.0005

α	δ	C_L	C_Y	C_z	C_n
-0.12	7.16	0.0396	-0.0008	-0.0107	0.008
1.89	7.12	1.794	-0.0018	-0.0082	0.016
3.91	7.05	3.110	-0.0025	-0.0068	0.022
5.91	6.97	4.531	-0.0022	-0.0043	0.025
7.93	6.92	5.952	-0.0023	-0.0040	0.020
9.91	6.92	7.204	-0.0029	-0.0055	0.025
11.90	6.85	8.233	-0.0030	-0.0035	0.033

α	δ	C_L	C_Y	C_z	C_n
-0.03	14.34	0.964	-0.0030	-0.0164	0.0025
1.87	14.31	2.234	-0.0043	-0.0139	0.0035
3.77	14.25	3.528	-0.0054	-0.0117	0.0045
5.70	14.20	4.885	-0.0065	-0.0100	0.0050
7.61	14.15	6.108	-0.0068	-0.0097	0.0057
9.52	14.12	7.231	-0.0073	-0.0107	0.0055

α	δ	C_L	C_Y	C_z	C_n
-0.03	14.29	0.842	-0.0021	-0.0170	0.0022
1.87	14.26	2.197	-0.0038	-0.0137	0.0035
3.77	14.23	3.592	-0.0046	-0.0111	0.0041
5.70	14.15	4.939	-0.0056	-0.0093	0.0046
7.61	14.15	6.170	-0.0062	-0.0087	0.0050
9.52	14.14	7.307	-0.0067	-0.0105	0.0051
11.42	14.08	8.289	-0.0070	-0.0160	0.0052

TABLE I.- BASIC DATA FOR MODEL WITH AILERONS ON RIGHT WING - Continued

[Tail off]

(b) Midspan aileron - Continued

 $M = 0.94$ $M = 0.98$

α	δ	C_L	C_Y	C_z	C_n	α	δ	C_L	C_Y	C_z	C_n
-1.92	-14.43	-0.2123	-0.0058	0.0131	0.0036	-1.91	-14.28	-0.2093	-0.0065	0.0116	0.0039
0.34	-14.47	-0.0659	-0.0046	0.0156	0.0032	0.36	-14.33	-0.0513	-0.0050	0.0156	0.0034
2.61	-14.50	0.0882	-0.0031	0.0165	0.0021	2.63	-14.42	0.1111	-0.0030	0.0166	0.0021
4.	-14.59	0.2722	-0.0012	0.0177	0.0010	4.88	-14.53	0.2773	-0.0012	0.0175	0.0011
7.	-14.63	0.4264	0.0005	0.0210	-0.0000	7.11	-14.60	0.4263	0.0005	0.0200	0.0003
9.	-14.79	0.5589	0.0029	0.0224	0.0020	9.36	-14.78	0.5796	0.0032	0.0205	-0.0022
11.	-14.98	0.6481	0.0035	0.0179	0.0028	11.55	-14.97	0.7035	0.0061	0.0220	-0.0045
13.	-15.23	0.7352	0.0046	0.0144	0.0040	13.72	-15.12	0.8141	0.0084	0.0220	-0.0064
15.	-15.39	0.8441	0.0079	0.0135	0.0056	15.89	-15.31	0.9288	0.0122	0.0224	-0.0090
17.	-15.47	0.9289	0.0091	0.0128	0.0070	18.04	-15.55	1.0144	0.0147	0.0188	-0.0111
20.	-15.57	1.0031	0.0086	0.0117	0.0086	20.18	-15.67	1.0823	0.0155	0.0155	-0.0122
22.	-15.64	1.0579	0.0020	0.0081	0.0069	22.29	-15.77	1.1405	0.0092	0.0131	-0.0122
24.	-15.81	1.1186	0.0105	0.0060	0.0045						

α	δ	C_L	C_Y	C_z	C_n	α	δ	C_L	C_Y	C_z	C_n
-1.93	-7.21	-0.1946	-0.0028	0.0070	0.0011	-1.89	-7.12	-0.1736	-0.0025	0.0061	0.0011
0.35	-7.25	-0.0389	-0.0015	0.0088	0.0007	0.37	-7.18	-0.0221	-0.0016	0.0080	0.0007
2.63	-7.32	0.1243	-0.0005	0.0101	0.0002	2.62	-7.28	0.1315	-0.0002	0.0091	0.0004
4.89	-7.39	0.3014	0.0009	0.0109	-0.0004	4.87	-7.37	0.2968	0.0010	0.0104	-0.0002
7.14	-7.48	0.4621	0.0021	0.0121	-0.0013	7.11	-7.47	0.4515	0.0019	0.0128	-0.0007
9.35	-7.62	0.5948	0.0037	0.0124	-0.0027	9.32	-7.66	0.5954	0.0043	0.0135	-0.0024
11.56	-7.76	0.6915	0.0039	0.0098	0.0028	11.52	-7.84	0.7266	0.0062	0.0133	-0.0040
13.68	-7.97	0.7632	0.0042	0.0075	-0.0034	13.69	-8.00	0.8424	0.0079	0.0128	-0.0053
15.82	-8.04	0.8734	0.0063	0.0068	0.0042	15.90	-8.06	0.9722	0.0101	0.0130	-0.0073
17.97	-8.21	0.9595	0.0071	0.0065	-0.0050	18.04	-8.24	1.0325	0.0106	0.0096	-0.0073
20.09	-8.22	1.0031	0.0060	0.0058	0.0059	20.17	-8.41	1.0944	0.0100	0.0077	-0.0085
22.17	-8.37	1.0851	-0.0010	0.0033	-0.0046	22.30	-8.51	1.1622	-0.0047	0.0064	-0.0086
24.26	-8.46	1.1346	-0.0144	0.0006	0.0002	24.40	-8.58	1.2160	-0.0094	0.0050	-0.0076
26.38	-8.56	1.1880	-0.0320	-0.0020	0.0047	26.51	-8.65	1.2731	-0.0256	0.0072	-0.0058

α	δ	C_L	C_Y	C_z	C_n	α	δ	C_L	C_Y	C_z	C_n
-1.36	0.01	-0.1079	-0.0006	0.0019	-0.0003	-3.62	0.17	-0.2470	0.0004	-0.0017	-0.0002
0.37	0.00	0.0109	-0.0001	0.0008	-0.0001	-1.60	0.09	-0.1111	0.0006	-0.0010	0.0001
1.42	-0.01	0.0896	-0.0001	-0.0002	0.0000	0.46	-0.01	0.0171	0.0003	-0.0005	0.0001
2.40	-0.03	0.1600	-0.0000	-0.0000	0.0001	1.49	-0.05	0.0842	0.0006	-0.0006	0.0001
4.36	-0.06	0.3086	0.0006	0.0016	0.0000	2.44	-0.10	0.1515	0.0007	-0.0002	0.0003
6.40	-0.16	0.4588	0.0009	0.0015	-0.0002	6.45	-0.25	0.4424	0.010	0.0013	0.0004
8.33	-0.29	0.5809	0.0014	0.0037	-0.0005	8.44	-0.36	0.5738	0.014	0.0004	0.0002
10.43	-0.32	0.6980	0.0015	0.0029	-0.0010	10.45	-0.53	0.6987	0.020	0.0002	0.0002
11.56	-0.37	0.7393	0.0019	0.0015	-0.0004	11.57	-0.61	0.7876	0.0033	0.0040	-0.0015
12.45	-0.46	0.7539	0.0012	0.0014	-0.0005	12.48	-0.69	0.8165	0.0020	0.0004	-0.0002
13.69	-0.63	0.7994	0.0025	0.0019	-0.0010	13.73	-0.81	0.9043	0.0042	0.0043	-0.0021
15.84	-0.72	0.9057	0.0019	0.0011	0.0012		-1.10				
17.98	-0.82	0.9952	0.0017	0.0012	-0.0015	20.19	-1.14	1.1412	-0.0004	0.0001	-0.0013
20.11	-0.91	1.0732	0.0002	0.0006	0.0017	22.31	-1.21	1.2037	-0.0017	0.0004	-0.0036
22.20	-0.97	1.1197	-0.0060	-0.0013	0.0002	24.42	-1.30	1.2608	-0.0129	-0.0011	-0.0022
24.28	-0.98	1.1657	-0.0175	-0.0038	0.0035	26.54	1.3132	-0.0183	0.0015	-0.0021	
26.40	-1.16	1.2220	-0.0218	-0.0050	0.0060						

α	δ	C_L	C_Y	C_z	C_n	α	δ	C_L	C_Y	C_z	C_n
-1.87	7.33	-0.0971	-0.0009	-0.0115	-0.0000	-1.88	7.27	-0.1100	-0.0006	-0.0108	0.0001
0.40	7.25	0.0566	-0.0015	-0.0106	0.0010	0.37	7.14	-0.0395	-0.0017	-0.0095	0.010
2.65	7.24	0.2136	-0.0018	-0.0082	0.0016	2.62	7.09	-0.1953	-0.0019	-0.0076	0.0116
4.90	7.18	0.3796	-0.0018	-0.0069	0.0018	4.89	7.04	-0.3646	-0.0018	-0.0056	0.0221
7.14	7.14	0.5328	-0.0013	-0.0054	0.0017	7.11	6.98	-0.5191	-0.0019	-0.0048	0.0119
9.36	7.04	0.6677	-0.0009	-0.0042	0.0017	9.33	6.85	-0.6628	-0.0013	-0.0038	0.0117
11.54	6.94	0.7767	-0.0027	-0.0085	0.0032	11.52	6.71	-0.7906	-0.0010	-0.0031	0.0117
13.70	6.95	0.8378	-0.0028	-0.0064	0.0028	13.73	6.52	-0.9309	-0.0010	-0.0027	0.0118
15.84	6.58	0.9231	-0.0004	-0.0020	0.0015	16.06	6.39	1.0496	-0.0022	-0.0045	0.0225
17.99	6.61	0.9986	-0.0001	-0.0010	0.0009	20.21	6.31	1.1608	-0.0034	-0.0037	0.0222
20.11	6.55	1.0659	-0.0015	-0.0009	0.0001						

α	δ	C_L	C_Y	C_z	C_n	α	δ	C_L	C_Y	C_z	C_n
-1.87	14.52	-0.0660	-0.0042	-0.0194	0.0023	-1.88	14.43	-0.0837	-0.0037	-0.0188	0.0025
0.41	14.47	0.0944	-0.0053	-0.0172	0.0033	0.39	14.33	-0.0739	-0.0055	-0.0170	0.0037
2.67	14.46	0.2461	-0.0059	-0.0148	0.0045	2.65	14.29	-0.2387	-0.0063	-0.0137	0.0048
4.92	14.39	0.4182	-0.0065	-0.0132	0.0051	4.88	14.24	-0.3909	-0.0065	-0.0114	0.0053
7.15	14.36	0.5659	-0.0063	-0.0123	0.0052	7.14	14.22	-0.5555	-0.0066	-0.0118	0.0055
9.38	14.24	0.7046	-0.0062	-0.0117	0.0053	9.33	14.14	-0.6854	-0.0063	-0.0102	0.0053
11.57	14.18	0.8087	-0.0079	-0.0147	0.0071	11.53	14.01	-0.8205	-0.0066	-0.0089	0.0058
						13.71	13.69	-0.9335	-0.0069	-0.0076	0.0062

TABLE I.- BASIC DATA FOR MODEL WITH AILERONS ON RIGHT WING - Continued

[Tail off]

(b) Midspan aileron - Concluded

 $M = 1.00$ $M = 1.03$

α	δ	C_L	C_Y	C_L	C_n	α	δ	C_L	C_Y	C_L	C_n
-1.90	-14.26	-1.965	-0.0067	0.0126	.0038	-1.92	-14.27	-1.998	-0.0049	0.0116	.0040
0.37	-14.31	-0.0447	-0.0052	0.0149	.0033	0.37	-14.33	-0.0388	-0.0036	0.0136	.0031
2.62	-14.41	.1056	-0.0032	0.0160	.0021	2.64	-14.41	.1180	-0.0018	0.0154	.0022
4.88	-14.53	.2686	-0.0014	0.0165	.0013	4.90	-14.55	.2847	-0.0003	0.0161	.0012
7.13	-14.60	.4292	.0003	0.0195	.0002	7.16	-14.62	.4424	.0017	0.0190	.0005
9.34	-14.78	.5642	.0029	0.0201	-0.0018	9.38	-14.79	.5747	.0045	0.0198	-0.0019
11.55	-14.99	.7011	.0061	0.0212	-0.0042	11.58	-15.00	.6993	.0074	0.0211	-0.0044
13.71	-15.18	.8150	.0087	0.0210	-0.0063	13.74	-15.18	.8034	.0097	0.0206	-0.0062

-1.89	-7.08	-1.650	-0.0028	0.0062	.0013	-1.89	-7.07	-1.637	-0.0008	0.0056	.0013
0.36	-7.16	-0.220	-0.0019	0.0072	.0009	0.38	-7.16	-0.139	-0.0001	0.0066	.0009
2.62	-7.28	.1282	-0.0005	0.0086	.0005	2.64	-7.30	.1376	.0011	0.0079	.0005
4.87	-7.36	.2892	.0005	0.0101	-0.0002	4.90	-7.40	.3036	.0024	0.0100	-0.0001
7.11	-7.45	.4439	.0012	0.0125	-0.0005	7.13	-7.42	.4616	.0031	0.0134	-0.0008
9.32	-7.63	.5859	.0038	0.0137	-0.0023	9.36	-7.66	.5902	.0054	0.0134	-0.0023
11.51	-7.86	.7139	.0057	0.0130	-0.0038	11.55	-7.89	.7194	.0072	0.0127	-0.0040
13.68	-8.02	.8340	.0076	0.0128	-0.0052	13.72	-8.04	.8244	.0088	0.0122	-0.0052

-3.59	0.17	-2.398	.0002	-0.0015	-0.0002	-3.64	0.19	-2.523	.0002	-0.0020	-0.0002
-1.58	0.07	-1.120	.0001	-0.0011	-0.0000	-1.55	0.09	-1.082	.0000	-0.0014	0.001
0.49	0.00	.0176	.0005	-0.0007	.0002	-0.54	0.04	-0.433	.0003	-0.0007	0.001
1.49	-0.05	.0819	.0006	-0.0006	.0001	0.49	0.00	.0246	.0001	-0.0005	0.001
2.50	-1.10	.1527	.0007	-0.0000	.0003	1.52	-0.06	.0842	.0002	-0.0006	0.002
4.43	-1.18	.2866	.0010	-0.0006	.0004	2.50	-1.11	.1506	.0006	.0001	.0002
6.47	-2.26	.4257	.0013	.0009	.0004	4.49	-2.23	.2983	.0008	.0007	.0003
8.48	-3.36	.5646	.0018	.0017	.0002	6.44	-3.28	.4440	.0011	.0019	.0003
10.46	-4.56	.6897	.0019	.0012	-0.0003	8.47	-4.39	.5707	.0017	.0021	-0.0000
12.31	-6.69	.7964	.0019	.0013	-0.0005	10.46	-5.55	.6910	.0019	.0012	-0.0001

-1.88	7.26	-1.103	-0.0010	-0.0103	.0002	-1.87	7.25	-1.084	-0.0008	-0.0093	.0002
0.37	7.16	.0387	-0.0014	-0.0093	.0007	0.38	7.13	.0383	-0.0015	-0.0083	.0008
2.62	7.11	.1880	-0.0018	-0.0075	.0013	2.63	7.06	.1881	-0.0018	-0.0067	.0013
4.88	7.06	.3558	-0.0019	-0.0054	.0018	4.91	7.01	.3742	-0.0018	-0.0050	.0017
7.12	7.01	.5110	-0.0014	-0.0043	.0021	7.15	6.95	.5261	-0.0016	-0.0033	.0018
9.34	6.88	.6533	-0.0004	-0.0034	.0017	9.37	6.85	.6618	-0.0011	-0.0032	.0014
11.52	6.75	.7799	-0.0007	-0.0025	.0014	11.56	6.73	.7801	-0.0006	-0.0026	.0012

-1.86	14.40	-0.0773	-0.0045	-0.0181	.0023	-1.88	14.39	-0.0883	-0.0040	-0.0167	.0023
0.39	14.31	.0680	-0.0062	-0.0165	.0036	0.39	14.26	.0670	-0.0057	-0.0155	.0035
2.64	14.22	.2222	-0.0070	-0.0135	.0047	2.64	14.23	.2204	-0.0071	-0.0138	.0045
4.89	14.23	.3866	-0.0073	-0.0112	.0054	4.91	14.19	.4000	-0.0074	-0.0104	.0050
7.13	14.20	.5413	-0.0073	-0.0105	.0053	7.15	14.17	.5530	-0.0075	-0.0089	.0051
9.35	14.13	.6862	-0.0071	-0.0098	.0052	9.38	14.08	.6921	-0.0071	-0.0091	.0051
11.55	13.98	.8173	-0.0076	-0.0087	.0055	11.57	13.97	.8082	-0.0072	-0.0080	.0054
13.71	13.87	.9263	-0.0072	-0.0068	.0057	13.72	13.84	.9089	-0.0072	-0.0064	.0055

TABLE I.- BASIC DATA FOR MODEL WITH AILERONS ON RIGHT WING - Continued

[Tail off]

(c) Outboard aileron

M = 0.80

α	δ	C_L	C_Y	C_z	C_n
-0.01	-14.79	-0.0558	-0.0024	0.0129	.0019
3.99	-14.84	.1924	-0.0007	0.0134	.0011
8.02	-15.02	.4604	.0021	0.0126	-0.0012
11.98	-15.14	.6645	.0031	0.0102	-0.0027

M = 0.90

α	δ	C_L	C_Y	C_z	C_n
-0.01	-14.68	-0.0494	-0.0026	0.0120	.0027
3.99	-14.76	.2238	-0.0009	0.0122	.0018
8.02	-14.99	.4957	.0024	0.0128	-0.0005
11.98	-15.05	.6630	.0026	0.0104	-0.0016

α	δ	C_L	C_Y	C_z	C_n
-0.03	-7.41	-0.0350	-0.0004	0.0065	-0.0000
3.98	-7.43	.2151	.0007	0.0073	-0.0003
7.99	-7.59	.4854	.0016	0.0068	-0.0012
11.96	-7.69	.6786	.0026	0.0058	-0.0027
13.05	-7.70	.7452	.0030	0.0046	-0.0024
17.14	-7.70	.8689	.0025	0.0047	-0.0034
21.04	-7.72	.9187	.0014	0.0043	-0.0046
24.94	-7.80	1.0144	-0.0173	0.0004	.0025

α	δ	C_L	C_Y	C_z	C_n
-3.65	0.02	-0.2314	-0.0006	-0.0011	-0.0006
-1.56	0.01	.1010	-0.0005	-0.0012	-0.0004
-0.58	0.00	-0.0422	-0.0001	-0.0010	-0.0003
1.41	0.00	.0704	-0.0002	-0.0005	-0.0004
2.43	-0.01	.1334	.0001	-0.0005	-0.0002
4.47	-0.02	.2678	.0001	.0007	-0.0001
6.44	-0.12	.4029	.0003	.0010	.0001
8.38	-0.12	.5268	.0009	.0018	-0.0004
10.45	-0.11	.6167	.0009	.0014	-0.0007
11.39	-0.30	.6732	.0012	.0013	-0.0006
12.50	-0.11	.7238	.0007	.0011	-0.0006
13.53	-0.32	.7674	.0015	.0008	-0.0007
15.65	-0.33	.8405	.0012	.0011	-0.0013
17.72	-0.34	.8929	.0004	.0005	-0.0012
19.72	-0.37	.8983	-0.0006	.0003	-0.0014
21.79	-0.44	.9456	-0.0063	-0.0021	.0010
23.88	-0.50	.9937	-0.0166	-0.0065	.0073

α	δ	C_L	C_Y	C_z	C_n
-0.03	7.41	.0200	-0.0014	-0.0088	-0.0004
3.98	7.39	.2725	-0.0010	-0.0068	.0006
7.99	7.27	.5293	-0.0017	-0.0046	.0011
11.96	7.18	.7111	-0.0009	-0.0027	.0012
13.10	7.19	.7710	-0.0010	-0.0042	.0011
15.16	7.19	.8401	-0.0008	-0.0031	.0011
17.12	7.17	.9042	-0.0013	-0.0039	.0012
21.00	7.13	.9439	-0.0028	-0.0013	-0.0012
24.96	7.04	1.0453	-0.0175	-0.0072	.0075

α	δ	C_L	C_Y	C_z	C_n
-0.01	7.38	.0182	-0.0010	-0.0087	.0004
3.99	7.37	.2856	-0.0008	-0.0064	.0009
8.02	7.27	.5424	-0.0003	-0.0048	.0008
11.98	7.12	.7073	-0.0004	-0.0029	.0013
13.20	7.08	.7665	-0.0011	-0.0041	.0011
15.27	7.06	.8662	-0.0005	-0.0026	.0007
17.30	7.04	.9406	-0.0014	-0.0032	.0009
21.23	6.95	1.0088	-0.0038	-0.0038	.0034
25.25	6.80	1.1251	-0.0198	-0.0098	.0113

TABLE I.- BASIC DATA FOR MODEL WITH AILERONS ON RIGHT WING - Continued

[Tail off]

(c) Outboard aileron - Continued

M = 0.94

α	δ	C_L	C_Y	C_z	C_n
-0.01	-14.61	-0.0460	-0.0028	0.0110	0.0028
3.99	-14.70	0.2442	-0.0009	0.0125	0.0020
8.02	-14.91	0.5258	0.0026	0.0126	-0.0003
11.98	-15.10	0.7206	0.0039	0.0099	-0.0017

M = 0.98

α	δ	C_L	C_Y	C_z	C_n
-0.01	-14.45	-0.0389	-0.0034	0.0098	0.0031
3.99	-14.62	0.2521	-0.0007	0.0115	0.0021
8.02	-14.89	0.5348	0.0023	0.0126	0.0003
11.98	-15.20	0.7682	0.0063	0.0127	-0.0030

-0.03	-7.33	-0.0294	-0.0005	0.0063	0.0007
3.98	-7.38	0.2607	0.0012	0.0072	0.0003
7.99	-7.55	0.5424	0.0032	0.0081	-0.0011
11.96	-7.76	0.7187	0.0039	0.0072	-0.0022
13.33	-7.83	0.7972	0.0044	0.0054	-0.0019
17.33	-7.91	0.9591	0.0038	0.0052	-0.0029
21.38	-7.96	1.0841	-0.0008	0.0020	-0.0020
25.48	-8.12	1.1968	-0.0174	-0.0015	0.0024

-1.36	0.00	-1.079	-0.0006	-0.0019	-0.0003
0.37	0.00	0.0109	-0.0001	-0.0008	-0.0001
1.42	0.00	0.0896	-0.0001	-0.0002	-0.0000
2.40	0.00	0.1600	-0.0000	-0.0000	-0.0001
4.36	-0.05	0.3086	0.0006	0.0016	-0.0000
6.40	-1.14	0.4588	0.0009	0.0015	-0.0002
8.33	-0.36	0.5809	0.0016	0.0037	-0.0005
10.43	-0.45	0.6980	0.0015	0.0029	-0.0010
11.56	-0.50	0.7393	0.0019	0.0015	-0.0004
12.45	-0.64	0.7539	0.0012	0.0014	-0.0005
13.69	-0.56	0.7994	0.0025	0.0019	-0.0010
15.84	-0.60	0.9057	0.0019	0.0011	-0.0012
20.11	-0.84	1.0732	0.0002	0.0006	-0.0017
22.20	-0.83	1.1197	-0.0060	-0.0013	-0.0002
24.28	-0.92	1.1657	-0.0175	-0.0038	0.0035
26.40	-1.03	1.2220	-0.0218	-0.0050	0.0060

-0.03	7.32	0.0148	-0.0014	-0.0079	0.0006
3.98	7.34	0.3051	-0.0010	-0.0059	0.0012
7.99	7.20	0.5814	-0.0007	-0.0045	0.0006
11.96	7.05	0.7490	-0.0004	-0.0023	0.0011
13.27	6.99	0.8080	-0.0012	-0.0033	0.0013
15.31	6.91	0.9054	-0.0009	-0.0022	0.0009
17.35	6.92	0.9758	0.0000	-0.0009	-0.0000
21.48	6.80	1.1196	-0.0061	-0.0041	0.0027
25.39	6.70	1.2173	-0.0220	-0.0051	0.0081

-0.01	7.19	0.0075	-0.0015	-0.0074	0.0008
3.99	7.16	0.2788	-0.0013	-0.0038	0.0015
8.02	7.09	0.5667	-0.0007	-0.0026	0.0011
11.98	6.89	0.8029	-0.0001	-0.0021	0.0009
13.31	6.77	0.8797	-0.0001	-0.0007	0.0003
15.39	6.78	0.9845	0.0008	0.0001	-0.0001
17.44	6.69	1.0807	0.0014	0.0012	-0.0008
21.61	6.65	1.1962	-0.0046	-0.0013	0.0011

TABLE I. - BASIC DATA FOR MODEL WITH AILERONS ON RIGHT WING - Concluded

[ail off]

(c) Outboard aileron - Concluded

M = 1.00

α	δ	C_L	C_Y	C_z	C_n
-0.01	-14.63	-0.0399	-0.0035	0.0095	0.0031
3.99	-14.59	0.2313	-0.0008	0.0111	0.0022
8.02	-14.88	0.5170	0.0023	0.0123	0.0003
11.98	-15.21	0.7632	0.0068	0.0134	-0.0030

M = 1.03

α	δ	C_L	C_Y	C_z	C_n
-0.01	-14.38	-0.0327	-0.0041	0.0091	0.0031
3.99	-14.59	0.2416	-0.0015	0.0112	0.0019
8.02	-14.88	0.5316	0.0016	0.0133	0.0004
11.98	-15.21	0.7560	0.0058	0.0128	-0.0031

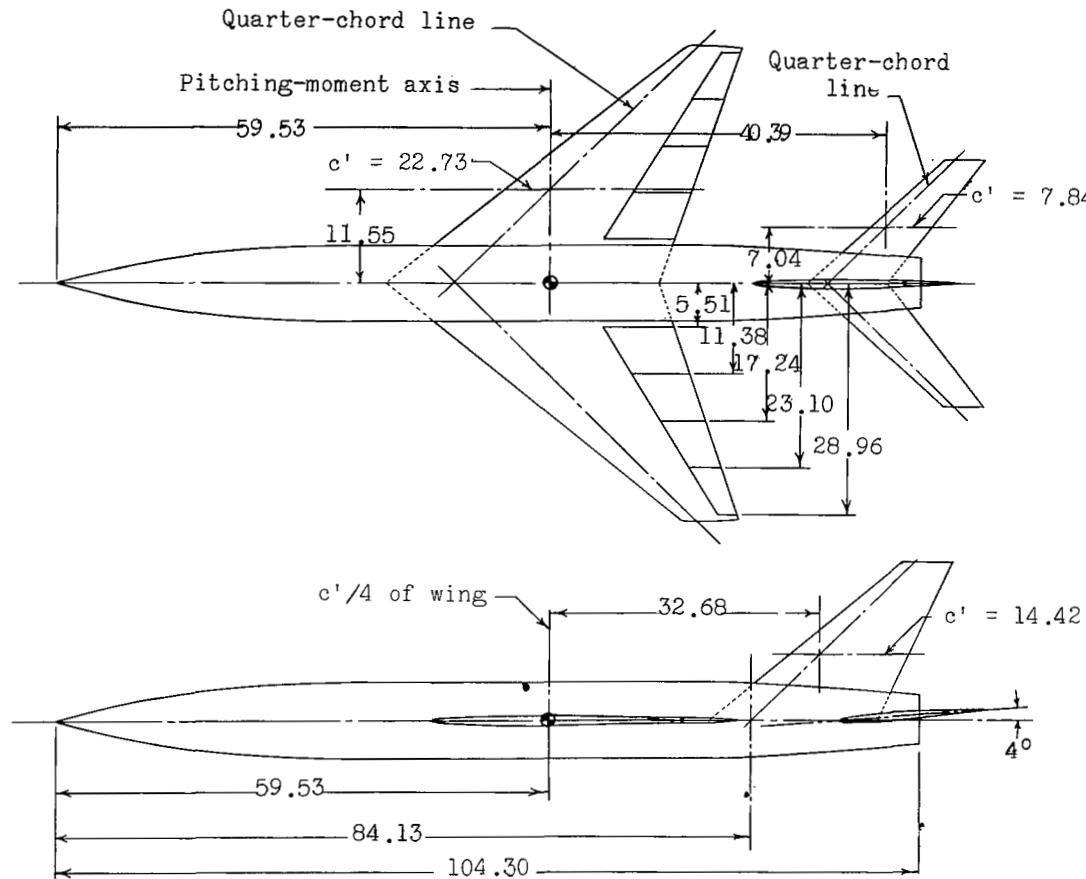
α	δ	C_L	C_Y	C_z	C_n
-0.03	-7.15	-0.0230	-0.0012	0.0044	0.0009
3.98	-7.31	0.2470	0.0008	0.0065	0.0005
7.99	-7.55	0.5334	0.0032	0.0086	-0.0008
11.96	-7.95	0.7688	0.0058	0.0090	-0.0029

α	δ	C_L	C_Y	C_z	C_n
-1.58	0.07	-0.1120	0.0001	-0.0011	-0.0000
0.49	0.01	0.0176	0.0005	-0.0007	0.0002
1.49	0.03	0.0819	0.0006	-0.0006	0.0001
2.50	-0.08	0.1527	0.0007	-0.0000	0.0003
4.43	-13	0.2866	0.0010	0.0006	0.0004
6.47	-25	0.4257	0.0013	0.0009	0.0004
8.48	-48	0.5646	0.0018	0.0017	0.0002
10.46	-71	0.6897	0.0019	0.0012	-0.0003
12.31	-82	0.7964	0.0019	0.0013	-0.0005

α	δ	C_L	C_Y	C_z	C_n
-3.64	0.15	-0.2523	0.0002	-0.0020	-0.0002
-1.55	0.06	-0.1082	0.0000	-0.0014	0.0001
-0.54	0.05	-0.0433	0.0003	-0.0007	0.0001
1.52	-0.04	0.0842	0.0002	-0.0006	0.0002
2.50	-0.09	0.1506	0.0006	0.0001	0.0002
4.49	-18	0.2983	0.0008	0.0007	0.0003
6.44	-25	0.4440	0.0011	0.0019	0.0003
8.47	-51	0.5707	0.0017	0.0021	-0.0000
10.46	-70	0.6910	0.0019	0.0012	-0.0001

α	δ	C_L	C_Y	C_z	C_n
-0.03	7.17	0.0116	-0.0016	-0.0067	0.0009
3.98	7.15	0.2767	-0.0011	-0.0042	0.0013
7.99	7.09	0.5596	-0.0006	-0.0023	0.0009
11.96	6.86	0.7990	0.0000	-0.0015	0.0008

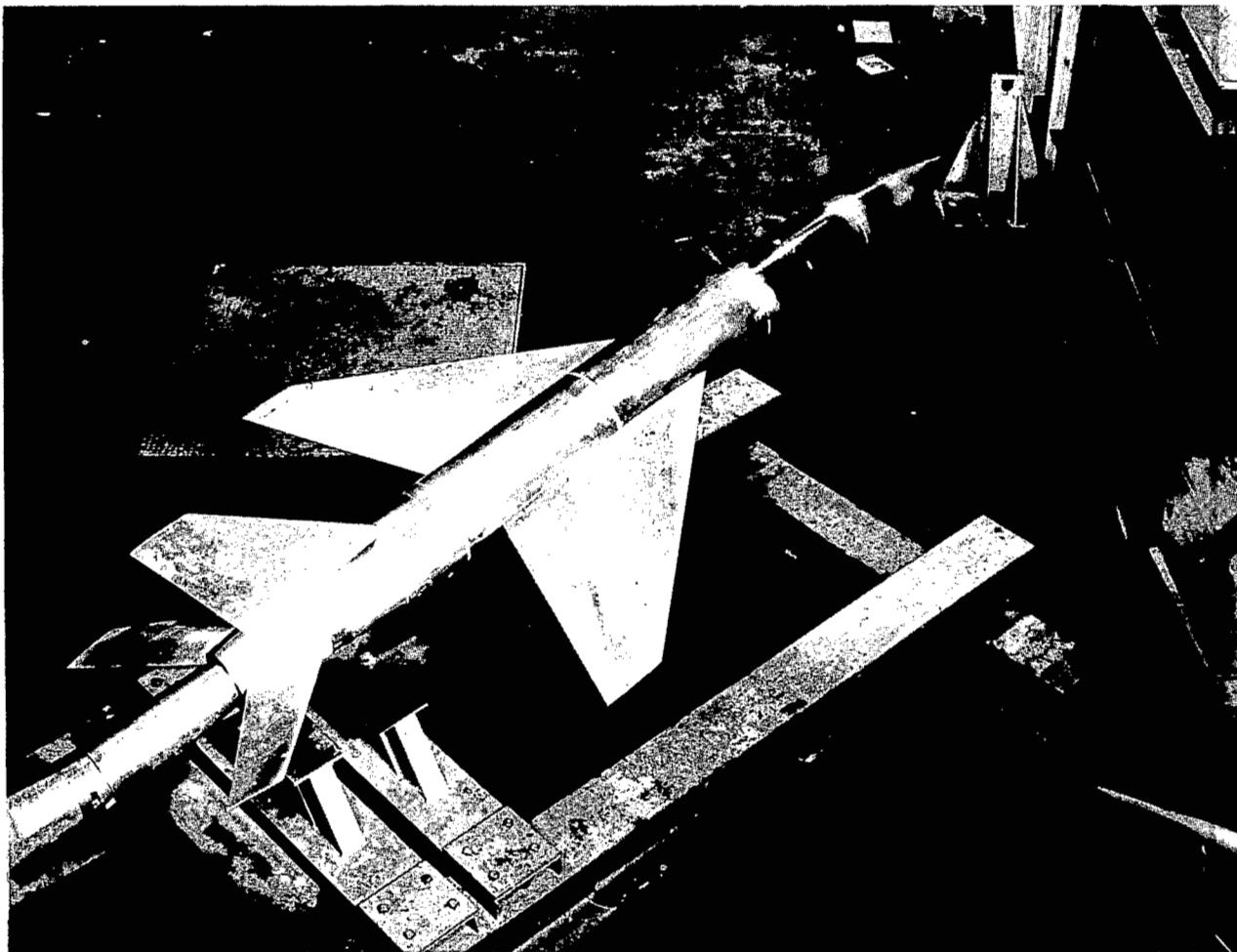
α	δ	C_L	C_Y	C_z	C_n
-0.01	7.15	0.0104	-0.0018	-0.0063	0.0012
3.98	7.08	0.2743	-0.0017	-0.0038	0.0013
7.99	7.07	0.5721	-0.0011	-0.0017	0.0010
11.96	6.84	0.7897	-0.0005	-0.0015	0.0005



	Wing	Horizontal tail	Vertical tail
Taper ratio	0.2	0.6	0.3
Aspect ratio	3.0	4.0	1.5
Area, sq ft	8.16	1.64	1.80
Airfoil section	NACA 65A004	NACA 65A006	NACA 65A005
Span	59.39	30.72	19.72
Root chord	33.00	9.60	20.22
Tip chord	6.60	5.76	6.06
$\Lambda_{c/4}$	45°	45°	45°

	Inboard	Midspan	Outboard
Aileron area, ft ²	.557	.430	.303
Moment of aileron area about roll axis, in. ³	882	1035	976

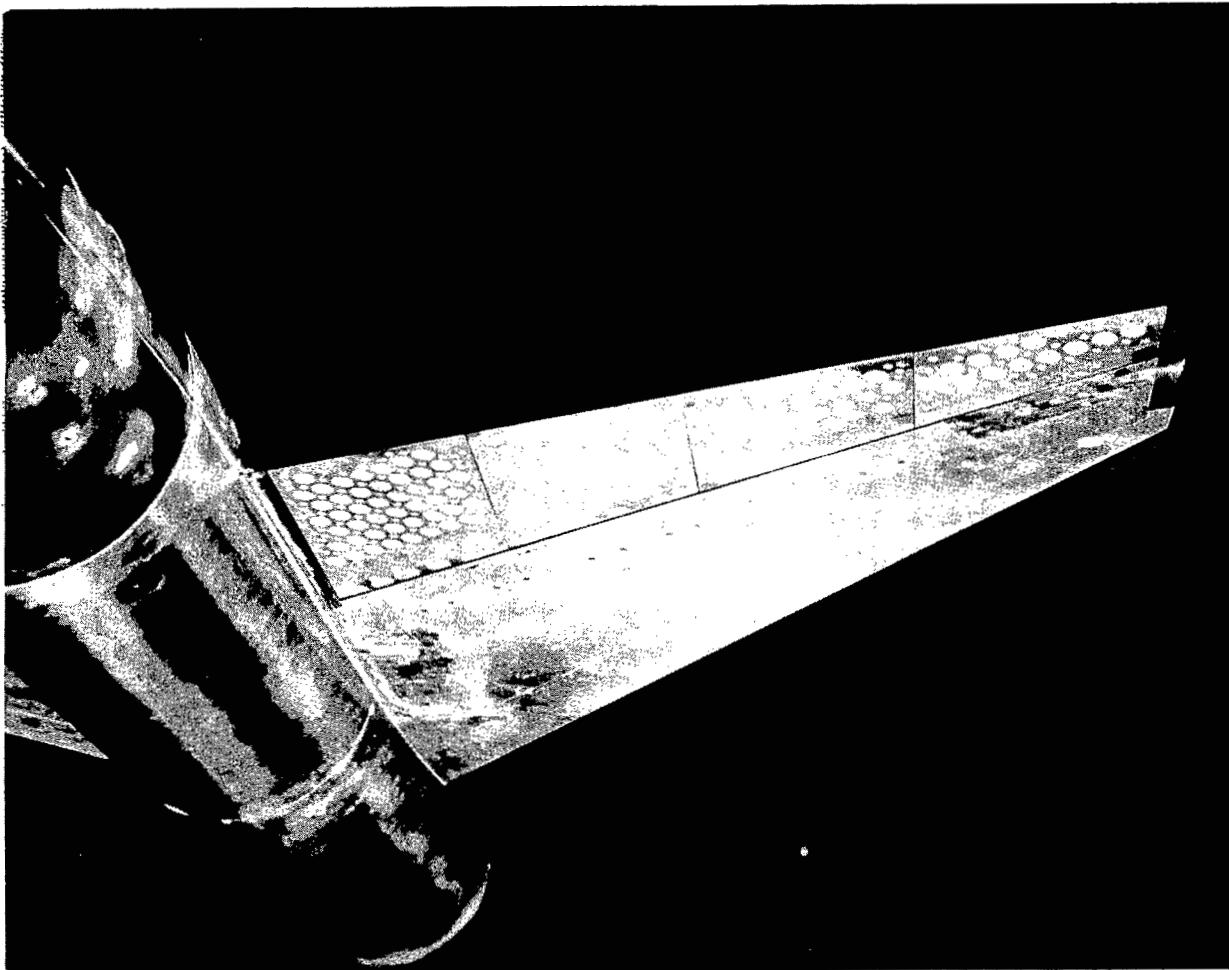
Figure 1.- Geometric details of model. All linear dimensions in inches.



L-89919.1

(a) Complete model.

Figure 2.- Photographs of model.



L-87670

(b) View of flaps on left wing.

Figure 2.- Concluded.

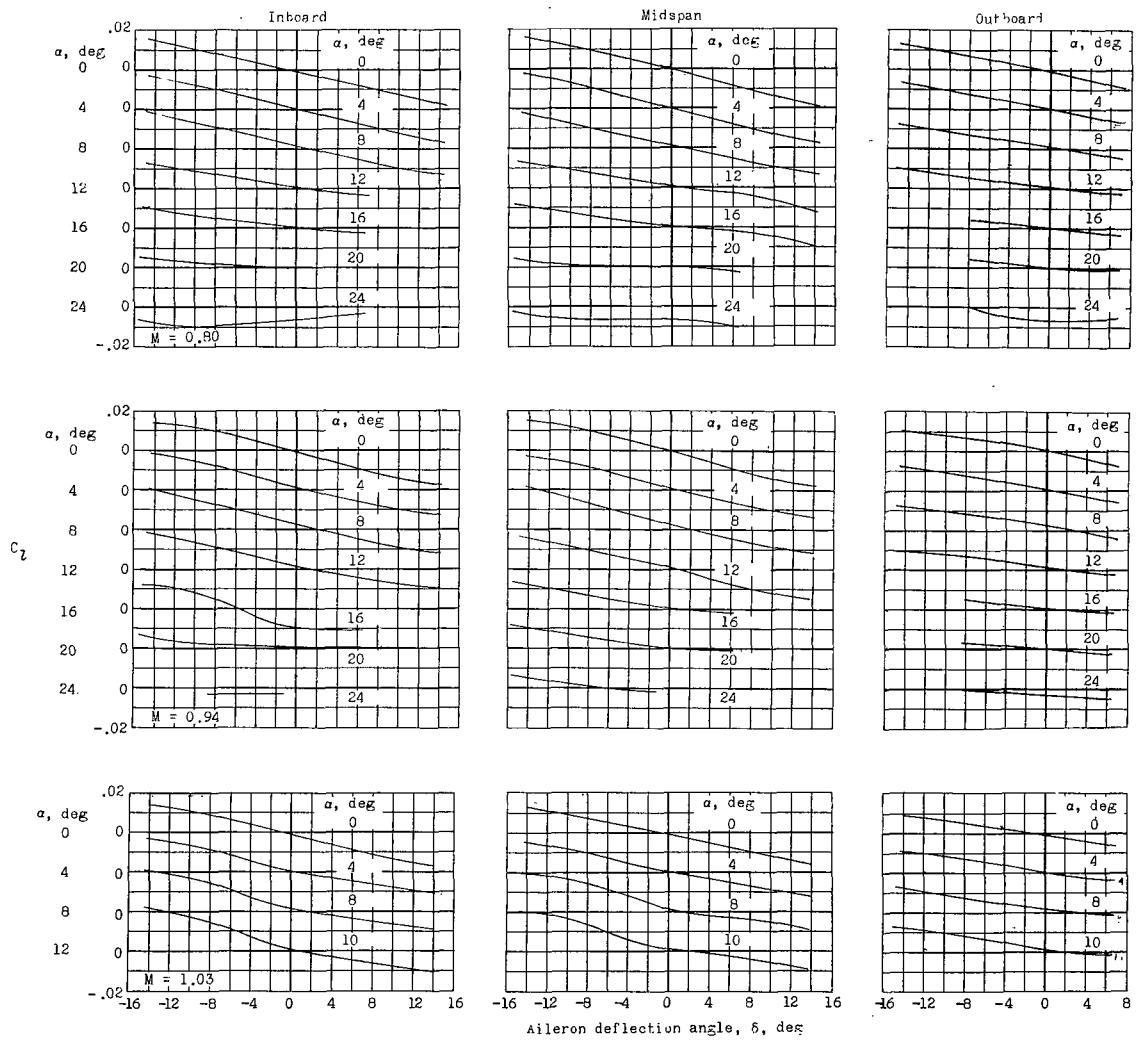


Figure 3.- Model rolling-moment characteristics for ailerons on right wing. Tail off.

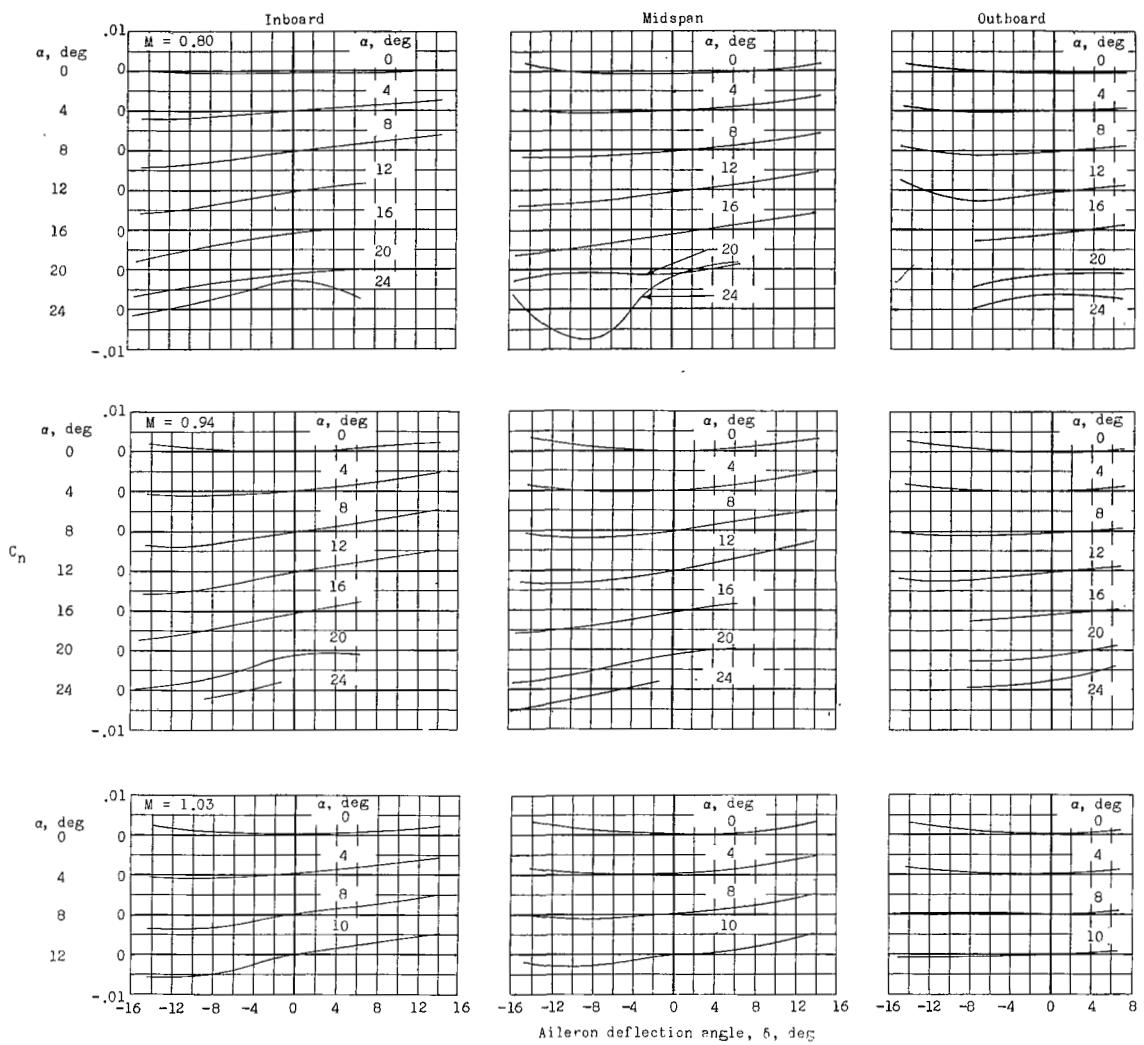


Figure 4.- Model yawing-moment characteristics for ailerons on right wing. Tail off.

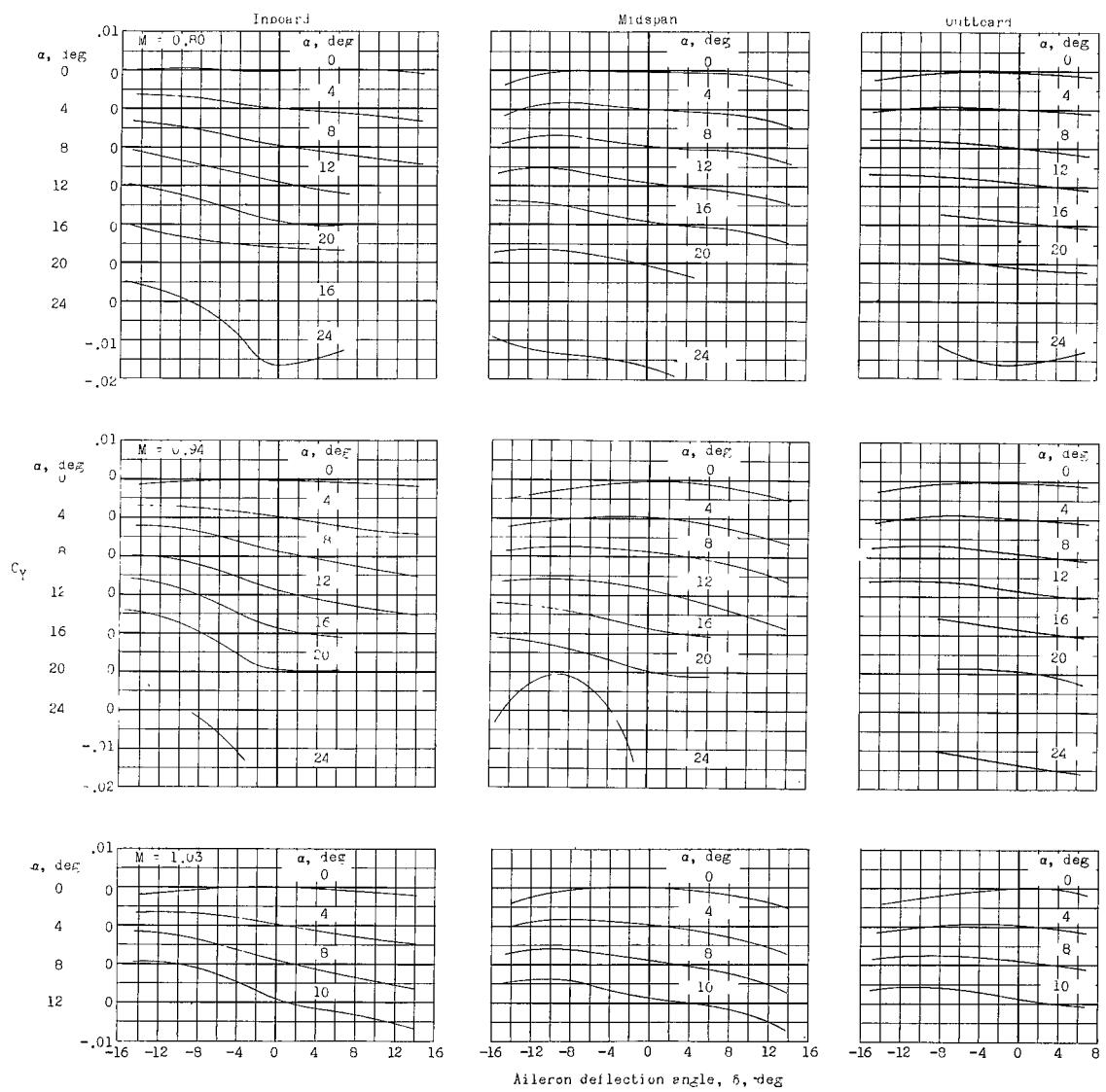


Figure 5.- Model lateral-force characteristics for ailerons on right wing. Tail off.

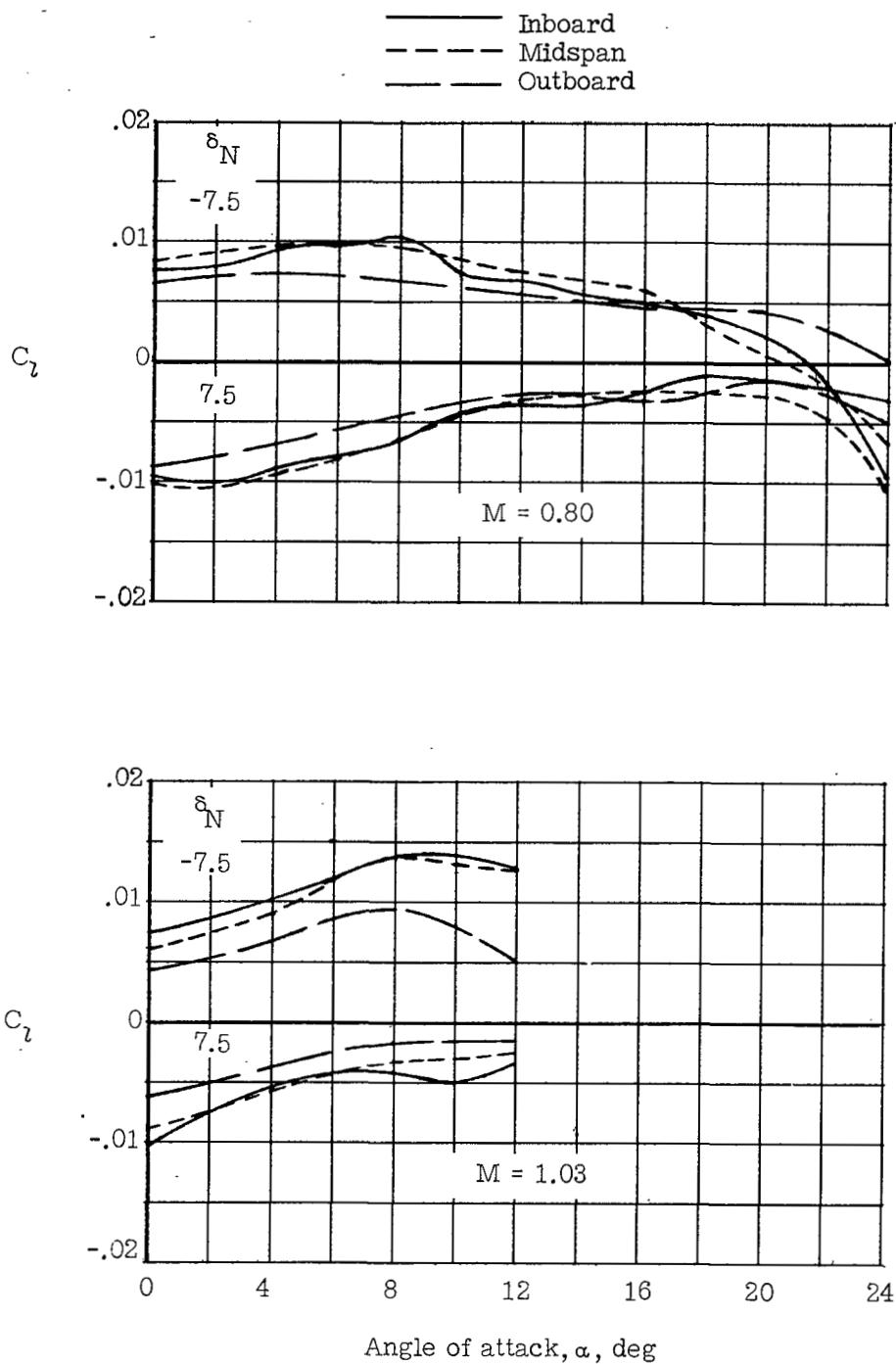


Figure 6.- Variation of rolling-moment coefficient with angle of attack.
Ailerons on right wing; tail off.

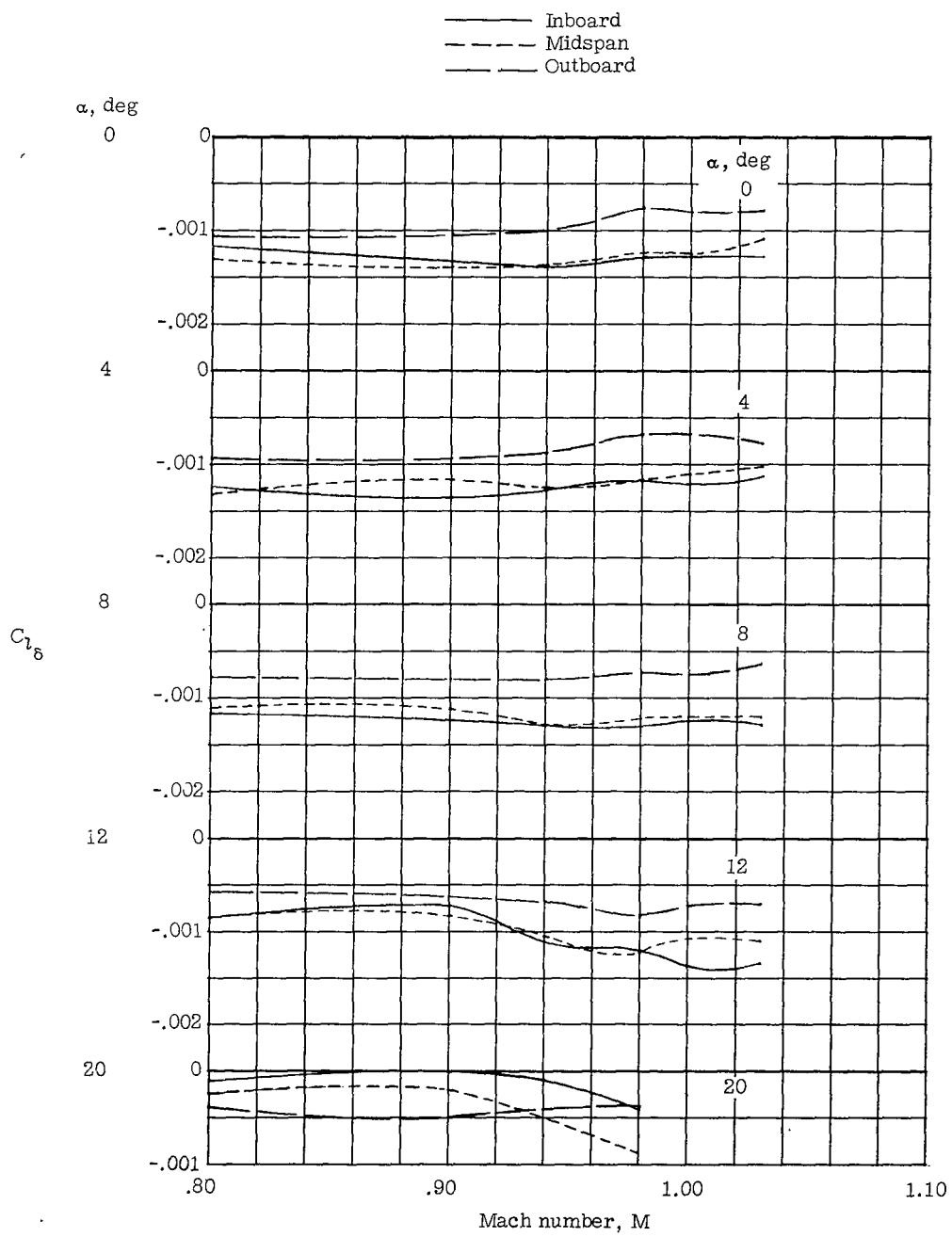
(a) C_{l_δ} .

Figure 7.- Effect of Mach number on the parameters C_{l_δ} and C_{L_δ} .
Ailerons on right wing; tail off.

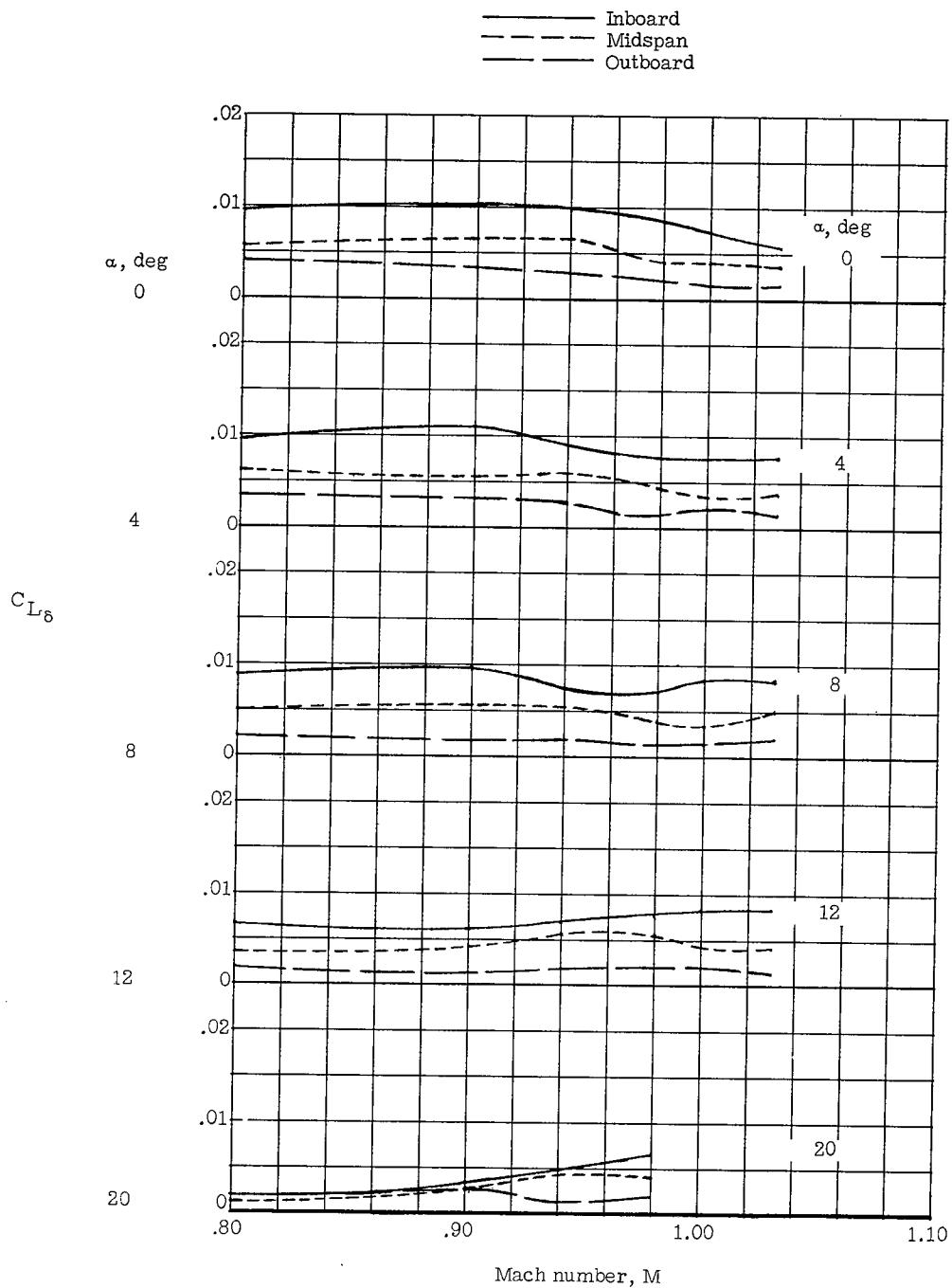
(b) $C_{L\delta}$.

Figure 7.- Concluded.

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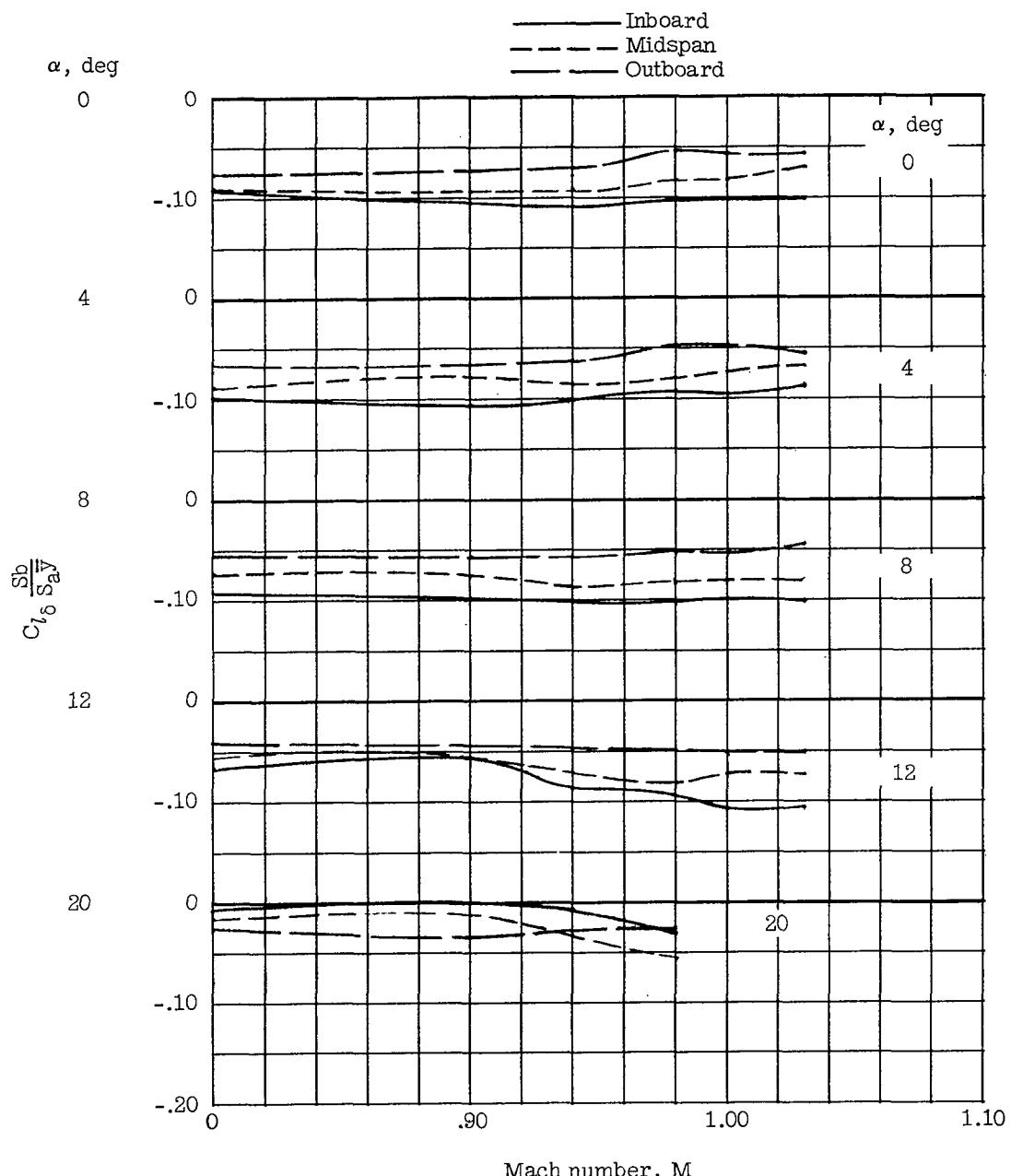
By Gerald Hieser and Charles F. Whitcomb
February 1957

Page 31: Replace figure 8(a) with corrected figure 8(a) attached, since a constant of conversion was inadvertently omitted in computing the data of the original plot.

Issued May 29, 1957

NACA RM L56J04

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$$(a) \quad C_{l\delta} \frac{S_b}{S_a \bar{y}}.$$

Figure 8.- Effect of Mach number on the parameters $C_{l\delta} \frac{S_b}{S_a \bar{y}}$ and $C_{L\delta} \frac{S}{S_a}$.
Ailerons on right wing; tail off.

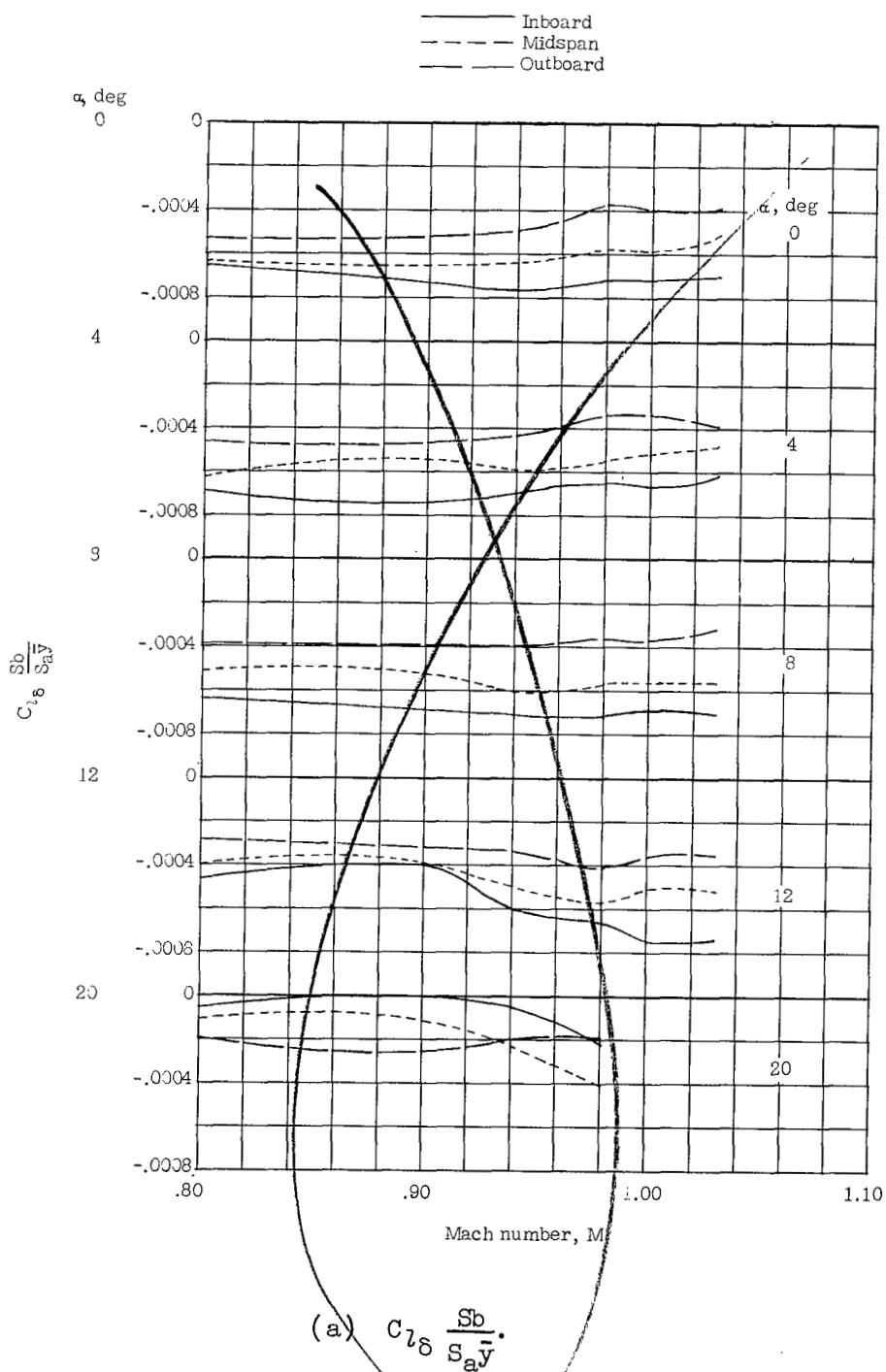
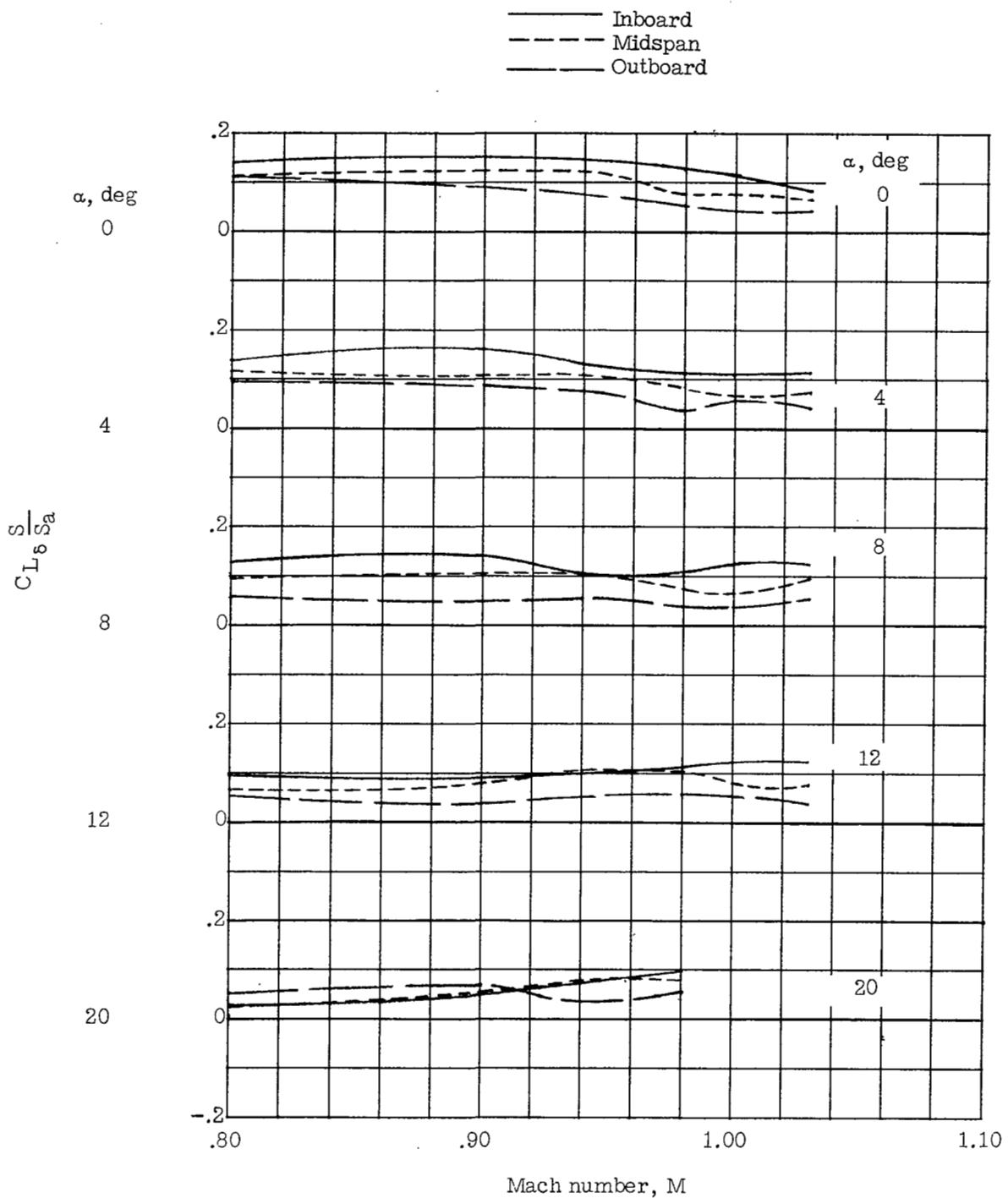


Figure 8.- Effect of Mach number on the parameters $C_l\delta \frac{S_b}{S_a y}$ and

$C_{L\delta} \frac{S}{S_a}$. Ailerons on right wing; tail off.



$$(b) \quad C_{L\delta} \frac{S}{S_a}$$

Figure 8.- Concluded.

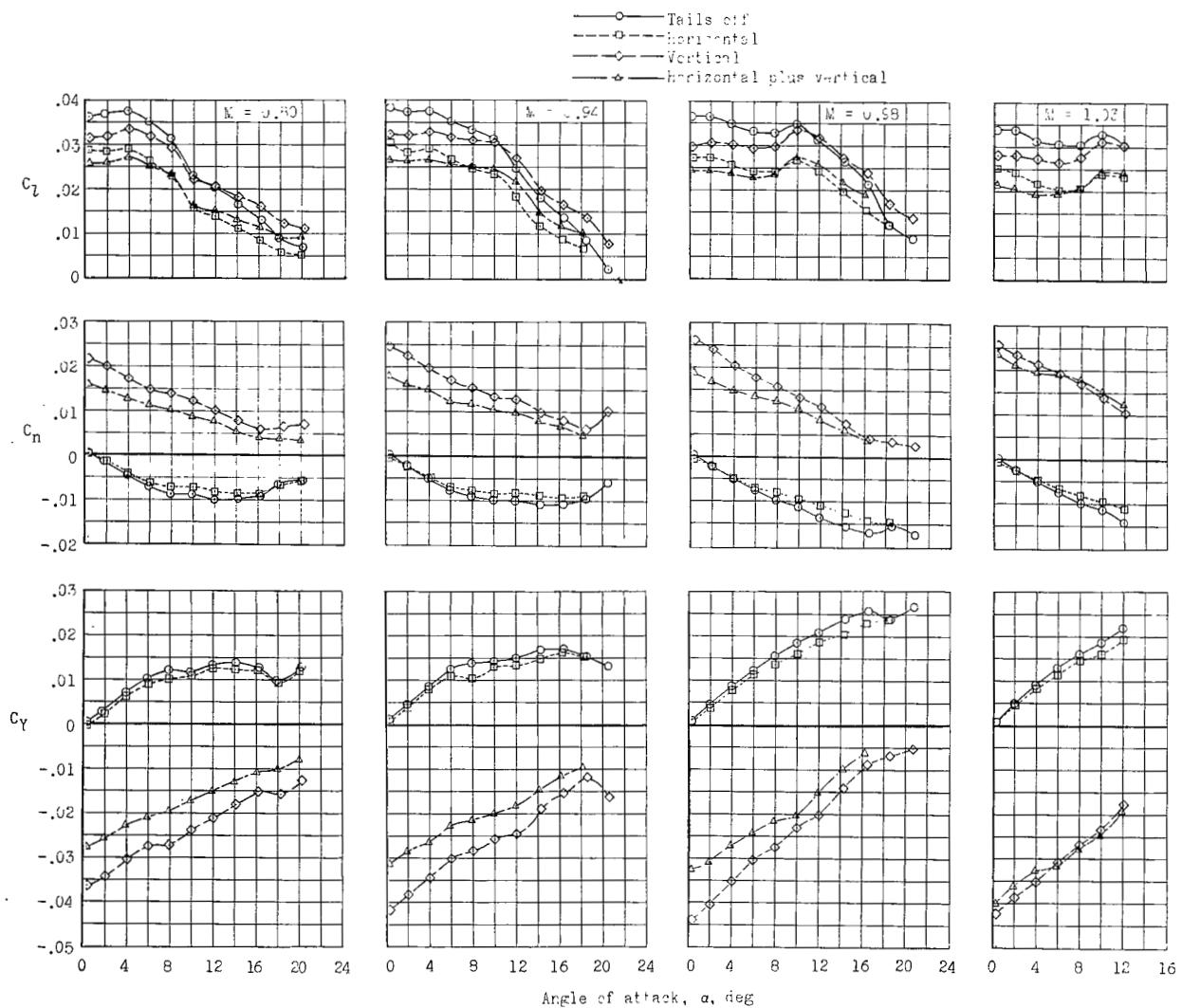


Figure 9.- Effect of tail on model lateral characteristics. Inboard
ailerons differentially deflected 15° .

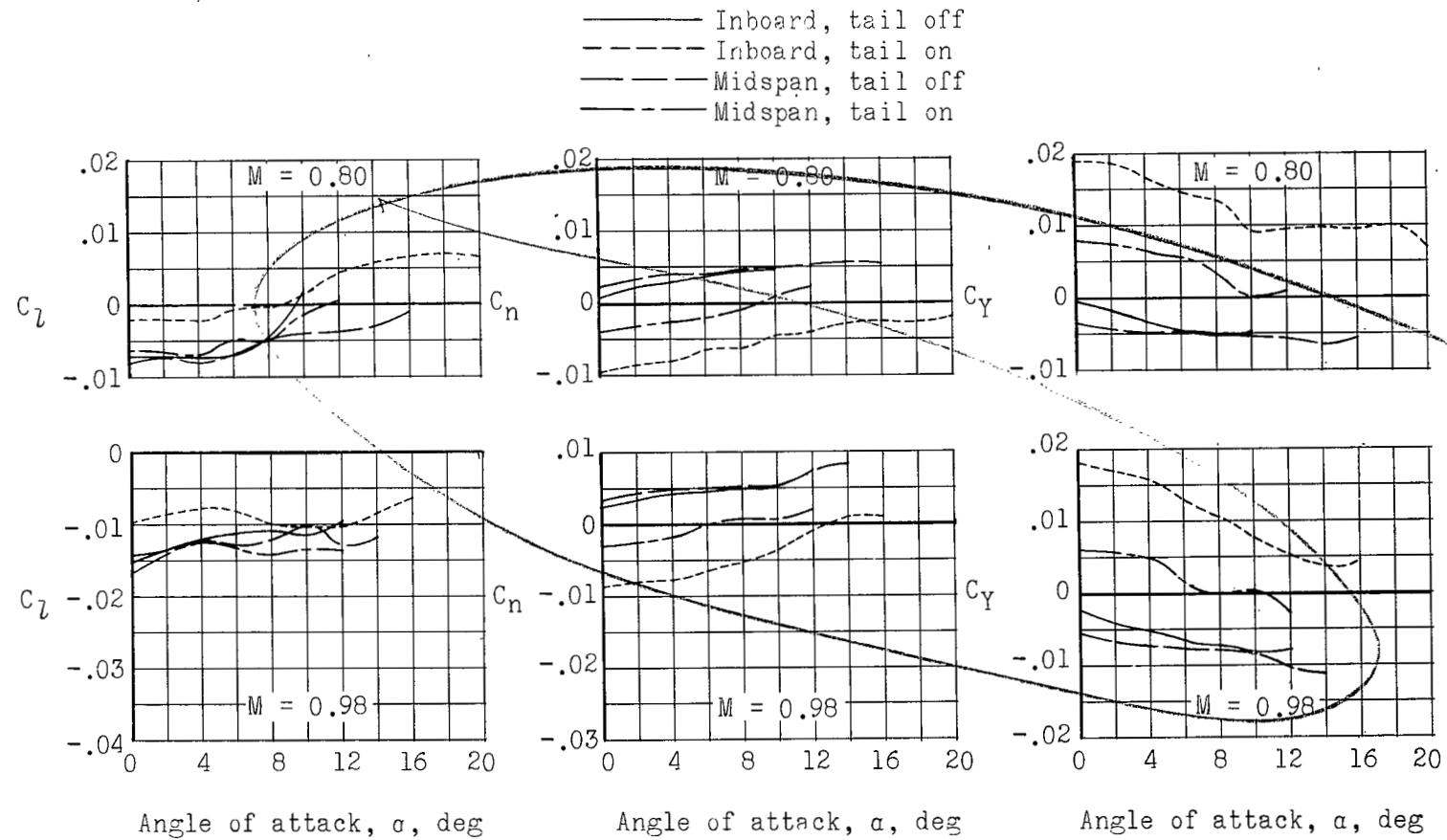


Figure 10.- Effect of tail on model lateral characteristics. Inboard and midspan ailerons on right wing; $\delta_N = 15^\circ$.

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